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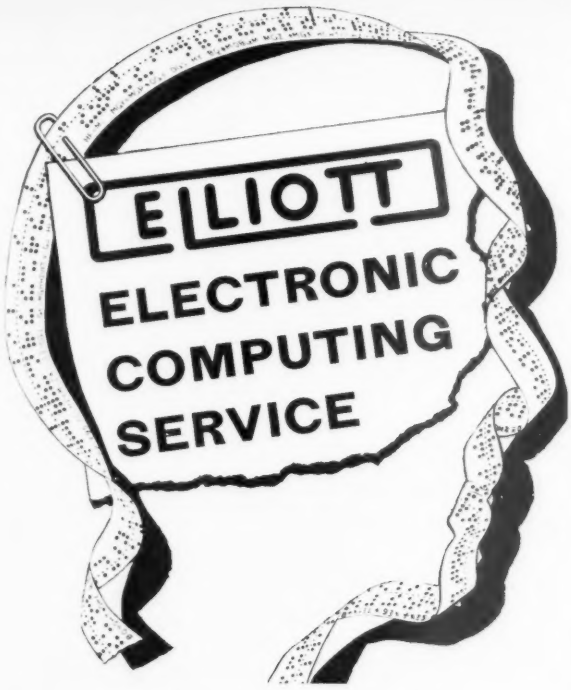

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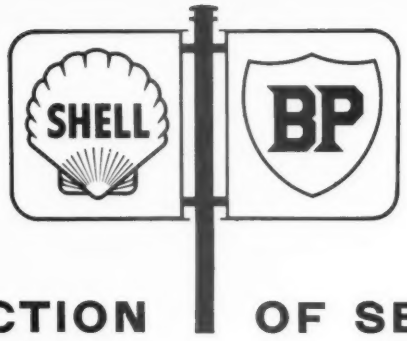

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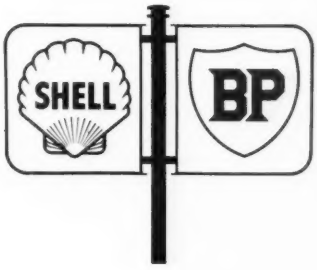

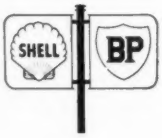

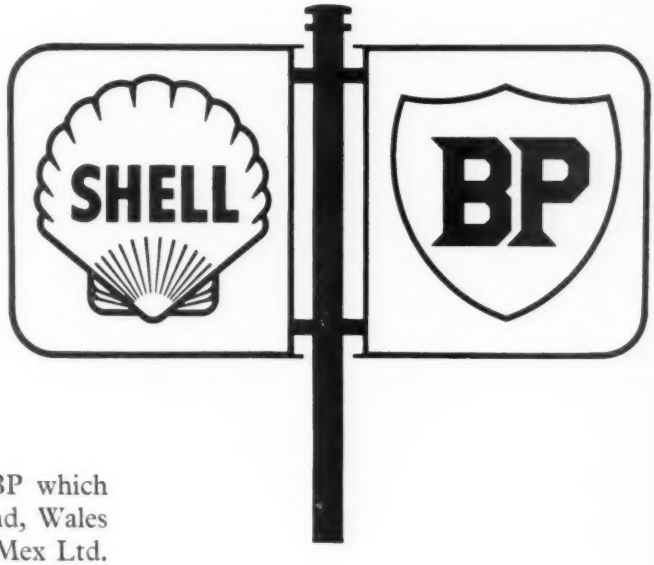

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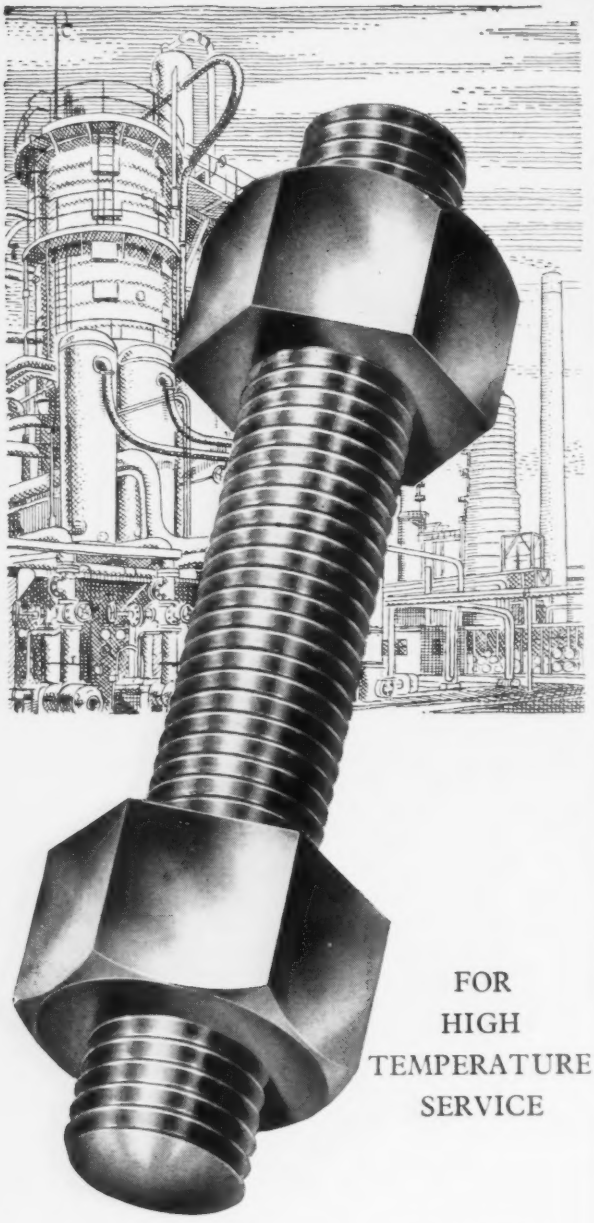

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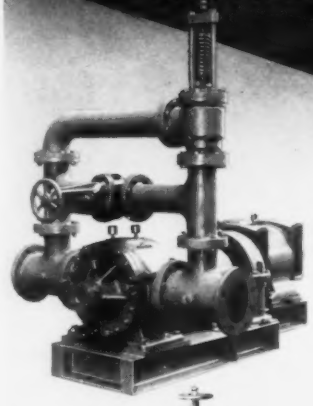
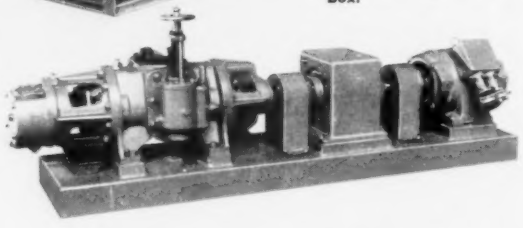


(Left)
Positive Acting Rotary Displacement Pump for the handling of Molasses and viscous fluids, electrically driven through totally enclosed Reduction Gear Box.

(Below)
Positive Acting Screw Displacement Spirit Pump, electrically driven through Wall Box.



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(Below)
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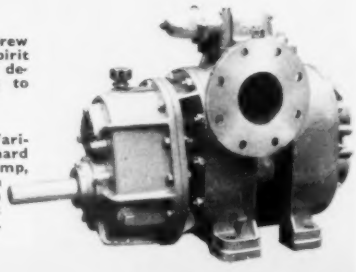

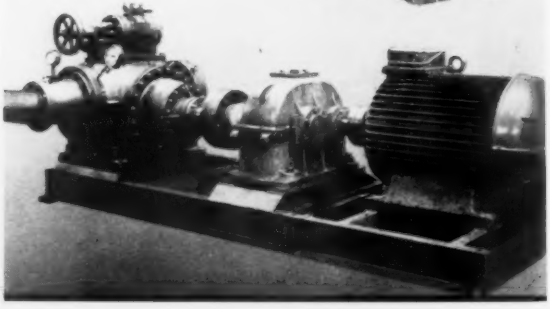

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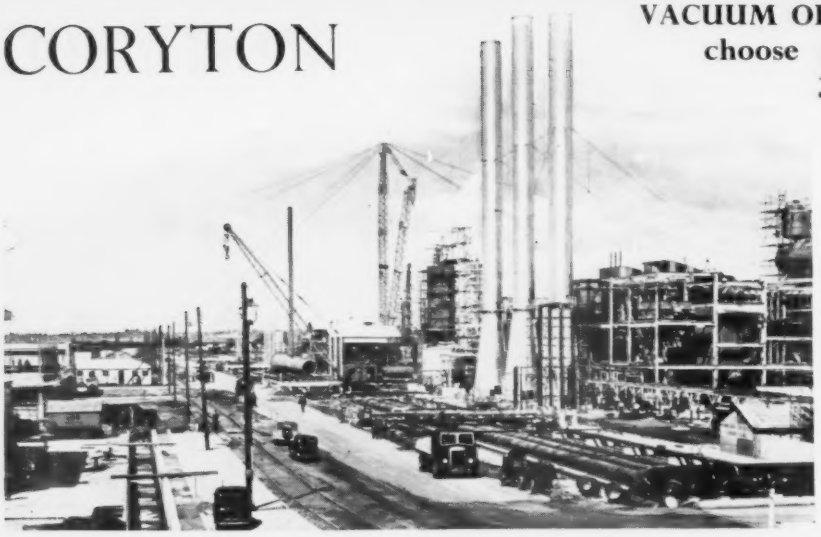

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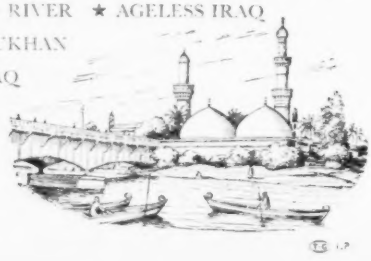

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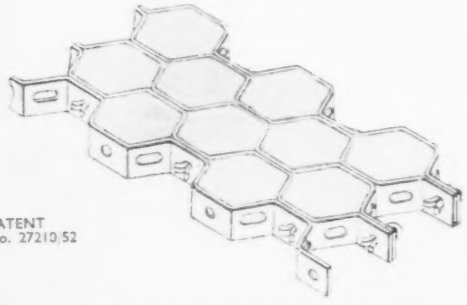

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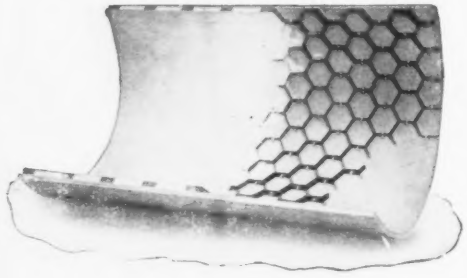

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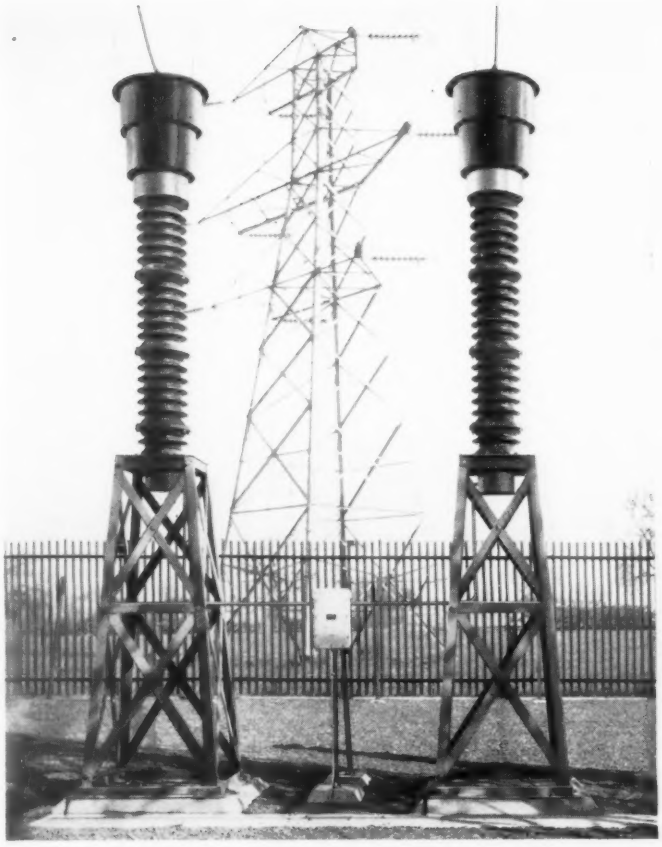
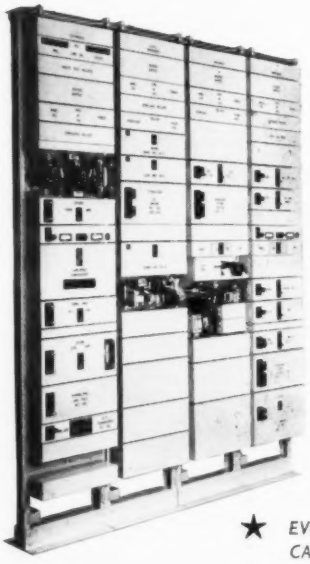


▲ *Line coupling equipment linking power-line carrier equipment to E.H.T. lines.*



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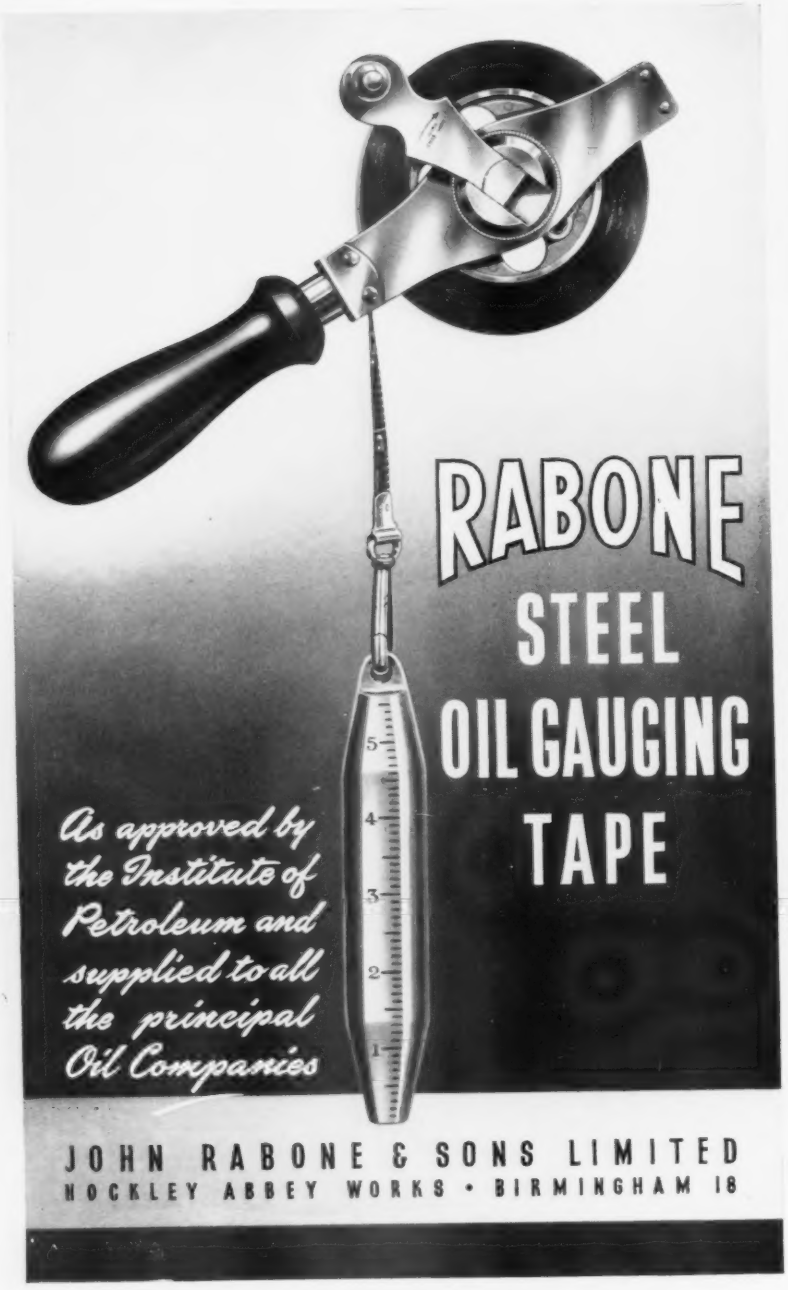
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The Economics of the Canadian Oil Industry*

By D. C. ION†

Introduction

Canada is indeed a young and virile country; all visitors are impressed by its size and the spirit of progressiveness now being shown.

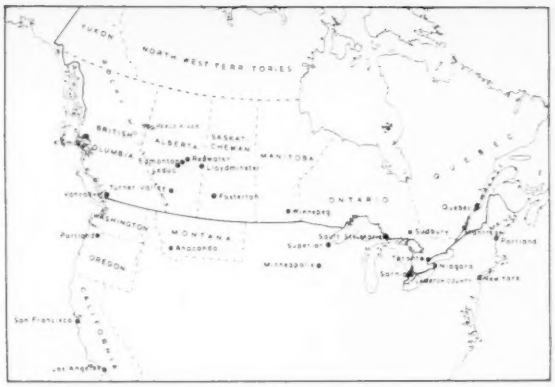
Such progressive feeling is particularly true of its oil industry which in its present form is also young. The first North American oil well is said to have been drilled in Lambton County, Ontario, in 1858, a year before Colonel Drake's well, yet Canada really only began to count as an oil producer with the discovery of the Leduc field in Alberta in 1947. Oil refining based on imported crude had, of course, been important in Montreal for many years but it was only after the supply of Prairie crude to Sarnia in 1951 that Ontario became an important refining centre.

To keep Canada in perspective, however, it must be remembered that as a whole Canada has a domestic oil market for major products of about the same size as that of the U.K., namely about 20 million tons per annum (m.t.a.).

Canada, however, cannot be considered in total for it is not a compact country but rather a ribbon of country 300 miles deep crossing the whole 3000 miles width of the North American continent.

Climate, Physiography, and Population

To the north is the Frozen North, a great expanse of land and water with an average annual temperature of from 15° to 20° Fahrenheit, and a present total population in the great area of the North West Territories and Yukon of only 25,000. This area is never going to carry a large population in spite of the fact that its furs, fish, timber, water power, maybe oil, and certainly and most importantly minerals make it a great storehouse of natural resources.



It is the long ribbon of country in the south which is likely for many years to be "effective Canada", a ribbon cut by climate, physiography, and population into five main segments. From west to east these segments are:

(1) The west coast area of British Columbia separated from the east by the high cordillera of the Rocky Mountains.

(2) The Prairies, an enormous area of flattish land, with a surprising amount of stagnant water in the form of fresh-water lakes, and predominantly agricultural.

(3) The Canadian Shield with its minerals and timber, the Great Lakes area and the peninsula of Ontario with its farms, orchards, cities, ports, and industry.

(4) The St. Lawrence waterway of Southern Quebec, and, finally,

(5) The Maritimes.

Fig 1 shows the concentration of population in the east where Southern Ontario and Southern Quebec, in a comparatively small area, contain over half the total population. Similarly in the west the population is virtually all in the south-eastern corner of British Columbia around Vancouver.

It must not be forgotten that there are also quite marked racial differences in the population. In British Columbia there is a predominantly British element. In the Prairies, particularly in Alberta, there is a very strong American population, conscious of its close ties with the people to the south. Ontario, one of the oldest settled areas, though mainly of British stock and proud of it, is strongly Canadian

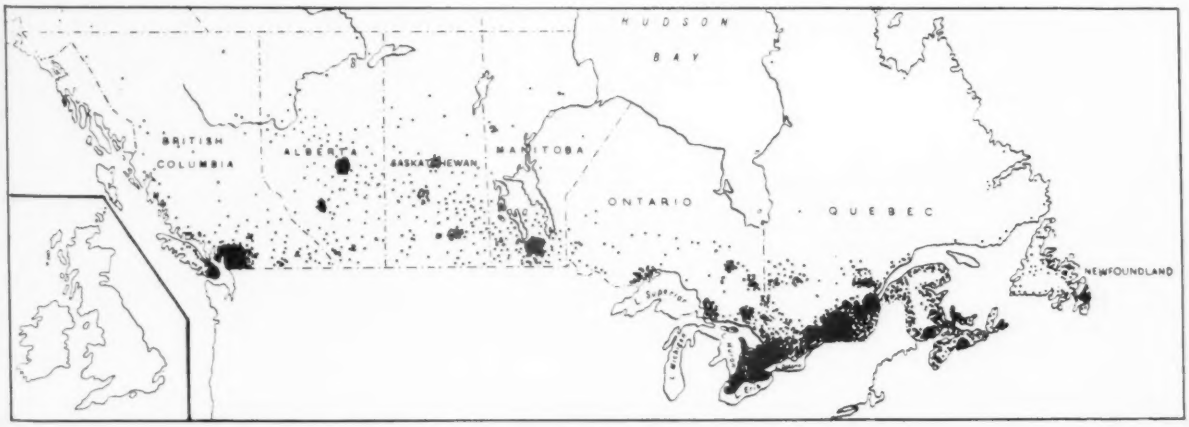


Fig 1. *Population densities in Canada.*

*Paper read to the Economics and Operations Group of the Institute of Petroleum, 4 January 1955.

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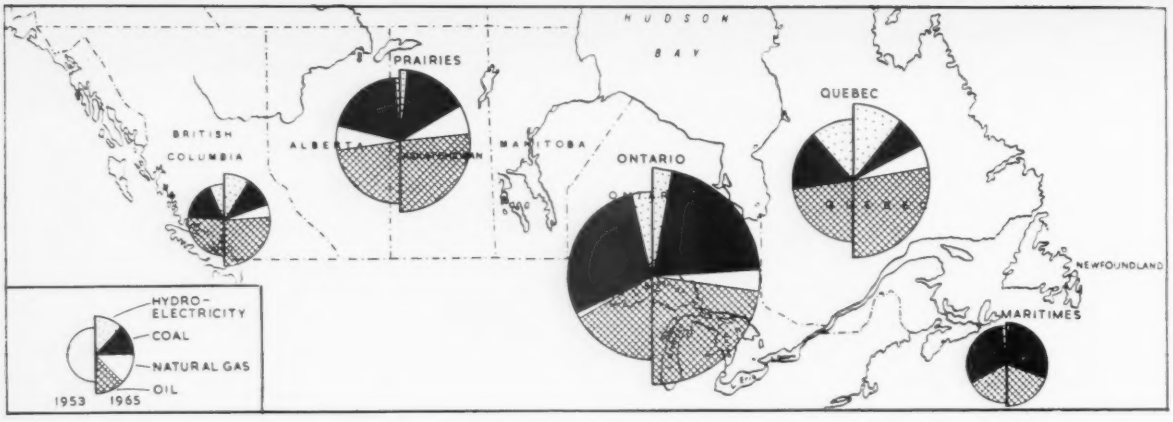

Fig 2. Total energy demand 1953 and 1965.

and is now absorbing many immigrants. Quebec is predominantly French and the Maritimes mainly British.

This ribbon of Southern Canada has for years been threaded by the two great trans-continental railroads of the Canadian Pacific Railway and Canadian National Railway, and, until the aeroplane became popular, these railroads were the sole binding threads of the country. Without them Canada would not have survived as an entity. Now the aeroplane, the car and the bus, and the great oil trunk lines and projected natural gas lines are running reinforcing threads through the ribbon which is Canada.

Whereas in 1900 the population of Canada was under 5½ millions, it is now 15 millions—a national average increase of 2 per cent per annum with varying rates of growth in the various segments. British Columbia (at 3·2 per cent p.a.) and Alberta are increasing most rapidly in population but they started small with just over 1 million people each. Ontario

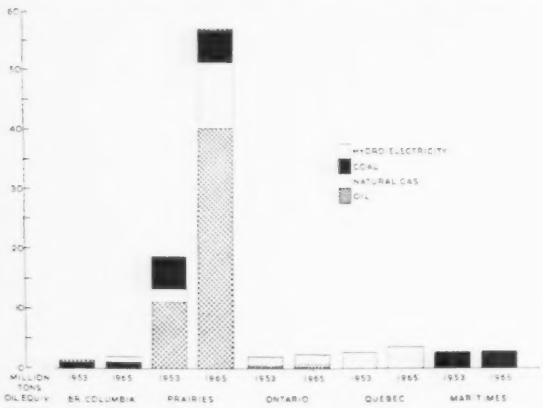

Fig 3. Indigenous supplies of energy in Canada (actual and possible).

on the other hand, with almost 5 million people, is increasing at 2·8 per cent p.a. Since 1900 Canada has followed the general trend towards urbanization, the proportion of town and city dwellers rising from one-third in 1900 to three-fifths at present.

Total Energy Demand

Fig 2 shows the total energy demand for the five southern geographical regions. It is clear from this diagram that no major shift in the geographical distribution of energy demand is anticipated during the next 10 years, and it is unlikely that it will be much different even in 20 years time. After that, however, British Columbia and the Prairies may well be taking a markedly bigger share.

Energy Use

The present pattern of energy use is interesting in comparison with those of the U.S.A. and U.K. The major difference is in the demands of transportation, which in Canada takes 39 per cent, in the U.S.A. 30 per cent and in the U.K. only 14 per cent of the total energy.

Competing Forms of Energy

The main change anticipated over the next ten years in the demand for competing forms of energy is the absorption, by natural gas and oil, of part of the share presently taken by coal.

Canada has great reserves of coal in Alberta and some in the Maritimes but transportation costs in respect of the former and production costs in the case of the latter make coal imports currently essential and these come mainly from the U.S.A. Such imports constitute an item in national finance which the Canadians would like to avoid.

Indigenous Supplies of Energy

The difficulties of achieving this can be seen from Fig 3, which shows by regions the allocation of Canadian indigenous energy supplies in 1953 and their possible allocation in 1965. The location of supply obviously does not fit the location of demand. The Peace River area of British Columbia on the east of the Rockies has, for the purposes of this chart, been taken as being in the Prairies, as geographically it is. The great hydro-electricity schemes of Canada likely to have been completed by 1965 are all included in this diagram, but these schemes all pale before the great contribution expected from oil.

Oil Prospects

Such a contribution depends upon Canadian proved and potential reserves. Canada has a possible oil-bearing sedimentary area of about half a million square miles and geological conditions exist which may be expected to provide much more oil than has yet been found, but nothing of the order of the Middle East reserves. Canadian crude production potential and consumption, now both about 20 million tons per annum, may well progress in step, doubling in 10 years and trebling in 20 years.

To assess the likelihood of achieving a level of production of this order, the effort already expended and that which must be expended in the future to win the necessary oil from the ground of the Prairies must be considered.

Production

Although in 1947 Albertan production totalled just under one million tons, the 1954 rate of production of Prairie crude was over 12 m.t.a. In December 1954, Albertan production reached the record annual level of 15 million tons and it is estimated that the present potential is about 20 m.t.a. as stated above. This potential has been built up in the past seven years.

Production Investment

Whereas in 1946, only 24 oil companies were operating in Western Canada, there are now ten times as many, while the amount spent on exploration and development has risen from $1 million a month in 1946 to $1 million a day in 1954.

In total in the past seven years almost $2000 million have been invested in Canadian oil. Of this total investment the proportion controlled in the U.S., by virtue of U.S. majority ownership of voting stock, had risen to 62 per cent at the end of 1951. This is disturbing to Canadians and even more so when one dissects these figures further.

In companies engaged mainly in refining, transportation, and marketing, U.S. control has always been high and has changed little, remaining about 69 per cent. On the other hand, in companies mainly devoted to exploration and development, U.S. control was less than 14 per cent at the end of the war but is now probably well over the 50 per cent mark, that is, the U.S.A. is gaining a majority control over future supplies as well as present facilities and markets.

It was natural that the U.S. oil industry should, following Leduc, pour money northward, for they had the money available, they had the personnel and equipment, and they needed the reserves.

By the U.S. taxation laws U.S. companies gain, through depletion allowances, more money for exploration and have therefore every incentive to spend money which is cheap compared with the taxed income of others. Secondly they have the men and equipment readily available and it will be many years before there are sufficient trained Canadians to overcome this preponderance. The question of the U.S. need for reserves raises the major enigma of the oil industry, namely the future of the U.S.A. domestic production.

It can be argued that the recent rush of the U.S. oil industry north to Canada, south into the offshore lands, and outwards into almost every other oil country is a sign that American companies feel that they must make tremendous efforts to find oil elsewhere because only thus can they maintain their share of the world oil industry, the U.S.A. itself being incapable of providing them with the oil required.

Therefore, unless there is a change in U.S. tax law or a major slump, the U.S. oil companies will continue to have cheap money and the incentive to spend it; they will have the men and they will have the incentive of needing reserves. Hence the bulk of the effort will continue.

The oil industry outside North America which has contributed only 10 per cent of the $2000 million may be expected to increase its holdings in Canada and the investing public will continue to have confidence as long as Canada is politically stable. In other words the effort being applied can be expected to continue and to increase as long as economic outlets can be obtained or assured for the oil—*and* gas—discovered.

Cost Per Barrel

It is very difficult to translate the total oil investment into the more practical concept of cost per barrel of oil. In the U.S.A. the cost of finding a barrel of new reserves varies from 50c to $2 according to locality and Struth gives the 1953 average as $1·08. In Canada the present average is probably much lower but will rise as exploration and development move further into the Frozen North and deeper into the rocks of the Rocky Mountains unless some new really big fields with high per well productivity are discovered.

Existing and Projected Oil and Gas Outlets

Prairie production of oil and natural gas is dependent upon trunk pipeline transmission to all markets but that of the Prairies itself. With existing facilities, Prairie natural gas, with the exception of that exported by special line to the copper mines at Anaconda in Montana, is restricted in its outlets to the local market. Although it is used in every possible way in the Prairies, this absorbs only a fraction of the potential supply.

The Albertan Government has been very conservative in its attitude to any approaches for permission to export gas. It is now satisfied, however, that there is sufficient gas for its own needs for many years even if some is exported.

Natural Gas Lines

Two schemes have therefore been put forward (see Fig 4). The first was that of the West Coast Gas Transmission Company for gas to be piped from the Peace River area to Portland, Oregon. This was blocked by the U.S. Federal Power Commission but now there is renewed hope that a scheme will go through. This will in effect mean the provision of ½ m.t.a. oil equivalent to Vancouver and 2½ m.t.a. to the U.S. North West. The main importance from a production angle is of course that the producers of the Peace River area will now start getting money back instead of always paying out.

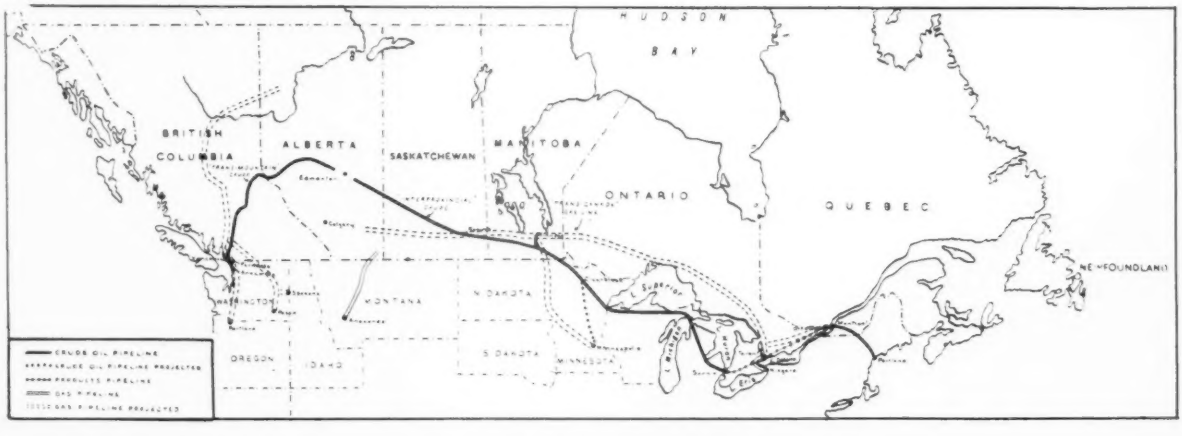

Fig 4. Oil and natural gas pipelines.

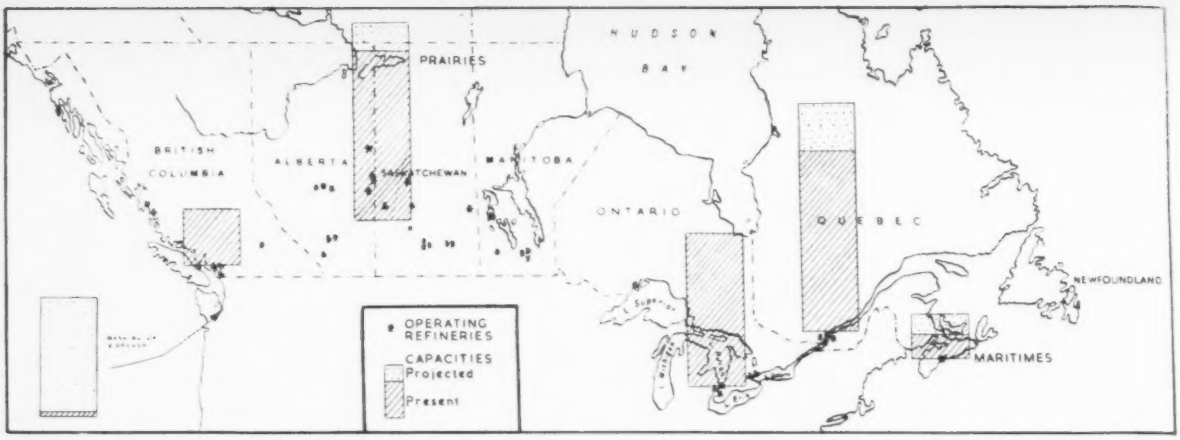

Fig 5. Location of Canadian oil refineries.

The second scheme is the great Trans-Canada gas line from Alberta to Montreal. The probable alignment will be further north at the eastern end than on Figure 4 to take advantage of less difficult terrain. Hence the great nickel mining area of Sudbury will be supplied by a spur southward from the line, rather than being on the main line as shown.

At the moment this is just a scheme because the backers have not yet obtained sufficient firm purchase contracts to guarantee the finance, the Albertans are still undecided exactly how the gathering lines are going to run or be financed, and the gas producers are not willing to sign supply contracts until they know the price they will be given.

However, the general impression is that these snags will be solved and that 1956 should see the start of construction and the end of 1957 or the beginning of 1958 should see the line commissioned. As planned, this should bring the equivalent of 1·6 million tons of oil to Montreal, 1·4 m.t.a. to Toronto and an export to the U.S.A., via spurs to Minneapolis and Niagara, of about 1½ m.t.a., in other words a total export from the Prairies of 4½ m.t.a. oil equivalent in the form of gas.

Toronto is already going over from coal gas to natural gas brought in from the United States which has been laid on to build up a market before the Trans-Canada line comes through. As with the Peace River scheme, however, a major point is that the gas producer will begin to get a return on money invested. This lack of market for gas and therefore lack of return has been a deterrent to exploration.

Oil Pipelines

There are three major crude lines and two major product lines. The trans-mountain line west from Edmonton to Vancouver had a throughput rate in the first half of 1954 of 1·7 m.t.a. but has an ultimate line capacity of 15 m.t.a.

The inter-provincial line has a present capacity of 7 m.t.a. down the Lakehead extension and an ultimate capacity of 15 m.t.a.

The third existing trunk line is that from Portland (Maine) to Montreal with a throughput rate in the first half of 1954 of 7 m.t.a. and a present and ultimate capacity of 9½ m.t.a. This line is only 240 miles long but it is not only a corner-cutting line but is also from an all-year ice-free port.

The two existing product lines are those from Sarnia east to Toronto and from Montreal west to Toronto.

Location of Canadian Refineries

Fig 5 shows the regional sub-division of the 27 m.t.a. present Canadian capacity and of the 30 m.t.a. total of present and projected capacity. Also shown is the projected refinery capacity in Washington and Oregon States of some 5 m.t.a. which the Canadians hope to fill with crude. Canadian refining capacity is in fact more than adequate for Canada's needs, for the 30 m.t.a. will probably be installed by 1956 when Canada's total overall demand will not be so high.

Transportation Costs and Sources of Supply

On the west coast only about a quarter of the current capacity of the pipeline is at present being used, and as a result the tariff is high, at 45 Canadian cents per barrel. Together with miscellaneous charges this adds about 58c per barrel to the well-head posted price and would mean, in the case of Redwater crude, a Vancouver export price of say 83·14 Canadian per barrel. Such oil landed in San Francisco at an ocean freight of U.S.M.C.—30 per cent would be cheaper than Middle East crude at posted price and same freight. At lower freights Albertan crude cannot compete.

Indeed, under present well-head prices, which are based on Canadian oil being competitive at Sarnia with U.S. mid-Continent oil, the export demand for Canadian oil in the west will not be stimulated until ocean freight rates harden permanently. If this happens, the increased throughput will lower pipeline charges and Canadian crude oil will become even more competitive in the west.

In the east the Maritimes are fed by sea-borne crude and products and there seems no real chance of any other pattern of supply unless, of course, the local prospects of finding oil confound all present thinking.

In Fig. 6 the demand of Ontario and Quebec has been combined in one circle. It can be seen that Ontario receives both Canadian crude at Sarnia, by the Inter-provincial line, and both crude and products from the U.S. mid-continent. Quebec receives crude by the St. Lawrence and the Portland–Montreal line, refines it, and pushes products both west to Toronto and east to the Maritimes. In other words the present boundary between Canadian and imported oil in the east is at Toronto.

It is 2200 miles from Alberta to Montreal and only 3000 miles from Venezuela to Montreal. The present inter-provincial pipeline tariff with other charges making 78c Canadian per barrel Redwater to Sarnia (1770 miles) is the approximate equivalent of a U.S.M.C. +100 per cent ocean rate for a comparable distance.

At posted prices and the low freight rates of last summer Middle East crude would be landed cheaper in Montreal than could have been done by line from Sarnia or from Saulte Ste. Marie even if either of these lines had been built.

There is, of course, the major problem of year-round supplies. With the freezing of the Great Lakes in the winter

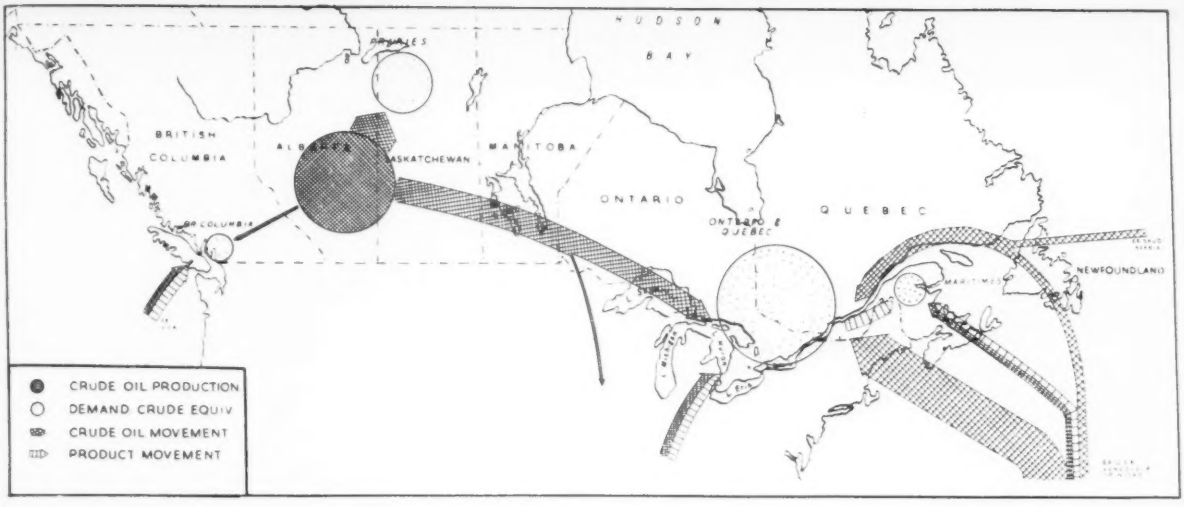

Fig 6. *Oil movements* 1953

it was only when the pipeline was extended from Superior all the way to Sarnia that Southern Ontario could be assured of year-round supplies and double handling avoided. Similarly only after 1941, when the Portland–Montreal line was built, was Montreal guaranteed year-round supplies untroubled by winter freezing.

The major Canadian market in Ontario and Quebec is, therefore, supplied from the west by Canadian oil and gas and from the east by imported oil. The boundary between these may with time move eastwards to Montreal but unless politics cause economy to be ignored it is difficult to see how Prairie oil could reach the Maritimes, for the sea haul is likely always to be cheaper than the land haul of equivalent length.

Possible Utilization of Pipeline Facilities

Future possibilities can also be examined from another viewpoint.

Canada has in existence oil transportation facilities which within a year would require 42 m.t.a. of crude oil to fill them.

It may well be 10 years before production equals this amount and Fig 7 may therefore be considered as a forecast of the position some years ahead.

On this diagram 15 m.t.a. could move westwards and, after providing for British Columbia and North Western U.S.A. refineries, some 7 m.t.a. would be available for export elsewhere. In less than 10 years California, it has been said by some, will require more than 7 m.t. of imported oil, but there is the political question as to whether the U.S. Government would allow this foreign oil to be imported.

Eastwards there is another 15 m.t.a. to be disposed of. In 10 years time Ontario could probably absorb the whole of this quantity.

Southwards the 2½ m.t.a. shown is already planned to enter an area with a current deficiency of over 10 m.t.a., supplied at the moment mainly from the south.

The political barrier which exists has been successfully crossed to the extent of 2½ m.t.a. but might become much more of an obstacle if larger quantities were involved. This is an obstacle barbed on both sides. The Canadians do not wish merely to be drawers of oil for the States and certainly will need to be assured of adequate reserves before exporting. On the other side the U.S. does not want any part to become dependent solely on a "foreign source" nor do its producers wish to cut back their production because of foreign oil. Another factor is the U.S. financial interest in profits from Canadian oil and yet another the U.S. administration's interest in hemispheric self-sufficiency as a matter of strategy. Thus even if the mid-Continent market does not expand beyond the figure of 2½ m.t.a., over 14 m.t.a. of oil have to be exported to fill the projected capacities of the existing Canadian crude oil pipelines. Without that export and the import into the east of almost equivalent amount, that is the integration of indigenous supply and demand with the wider

Fig 7. *Possible disposal of Prairie crude oil using existing and projected facilities* (*all quantities in million tons*).

world oil industry, Prairie oil will not on ordinary economics gain its full production potential.

It is therefore suggested that it is in Canada's own interests to export crude oil from the West Coast and South into the U.S. mid-Continent and import foreign oil into Eastern Canada.

Summary of Discussion

The chairman, Mr Masterson, opened the discussion himself and began by comparing the proposed Trans-Canadian gas line with Bechtel's project to pipe gas to Europe from the Middle East, and inferred that the Canadian scheme would go ahead whereas the other had been given up for political reasons. The Trans-Canadian gas line is supposed to be under construction by spring this year, though Mr Masterson thought this a rather optimistic forecast and Mr Ion agreed that the Canadians were inclined to exaggerate the state of progress which the scheme had reached.

On Mr Masterson's comment that the Canadians intend to build up a market immediately in the Ontario area by bringing in gas from the United States, Mr Ion said that this was being done but he feared American gas might thereby gain a tight hold on the market before Canadian gas became available.

E. Cooper-Scott, after mentioning the usual working estimates of the cost of finding and developing oil in this region, up to a dollar per barrel, went on to suggest that there might be some possibility of the companies trying to extend the oil pipelines a little further into the Montreal district. Disagreeing with this view, Mr Ion said that he did not think there was any likelihood of this from an economic point of view, as sea transport of oil was cheaper over equal distances than land transport, and hence Montreal could be more economically supplied by sea. However, there was the possibility of the politicians overruling the economics of the situation.

Bringing up a different topic, G. P. Glass asked whether the possible disposal of oil had been tied up with projected energy demand in the next ten years, and also queried Mr Ion's figures of exports to the United States, regarding these figures as rather low in view of the fact that the country was becoming increasingly a net importer of oil. Answering, Mr Ion said the future energy picture had been taken into account though looking so far ahead the figures were only approximate.

Concurring with Mr Ion that the whole problem of Canadian oil and gas development was very much bound up with the interplay of politico-economic considerations, Mr Thackeray put forward the idea that the two areas, Canada and the United States, should be treated as one economic unit from the point of view of oil supply. Mr Ion agreed that the only way to bring the Canadian oil industry to its full potential was by integration into the wider international oil industry.

Next, J. Clarke asked whether there was any notable consumption of individual products in Canada, and thought that the ratio of demand might correspond closely with that of the U.S.A. He also inquired about the nature of Canadian crudes. Mr Ion replied that there was no marked peculiarity about Canadian crudes though they do vary between themselves; on product demand, he pointed out that there was little consumption of natural gas in Canada as yet, and the main point of similarity with the United States was the high consumption of motor gasoline.

Showing Canadian oil against the world background, O. F. Thompson recalled that Canada could produce at present about 20 million tons of oil annually, very little in relation to a world figure of 700 million. Turning to the problems affecting Canadian oil, he wondered what the future trend of consumption in the U.S.A. might be and suggested that we might assume an appreciable rate of expansion in North American demand. American production, he thought, was likely to increase at least till 1960, but if the costs of finding and extracting United States oil rose, this would influence the position in Canada. Following on from these assumptions, if production costs rose, the next big question would be the cost of oil supplies from the Middle East. Here Mr Ion pointed out that a price ceiling was set by the cost of producing synthetic gasoline, which he had heard was already an economic proposition locally in Colorado.

Mr Masterson was unconvinced that experience and information available showed conclusively that, in the Canadian context, the cost of shipping oil 3000 miles should be lower than pumping it 2000 miles, and Mr Ion gave an example which he thought proved the point. Mr Rees-Jenkins supported Mr Ion on this question, and went on to suggest that in respect of the problem of integrating Canadian oil into the wider international industry, since it was the international oil industry which was controlling Canadian oil, the industry itself would bring about the required integration.

P. M. de Veulle asked Mr Ion for his opinion of the impact in Canada of the added gas outlet on the economics of oil production profitability. In reply, Mr Ion said that a lot depended on the price of the gas, which no one had yet worked out exactly; however, he thought the oil producers would stand to gain from gas sales and he did not believe the gas would have a very big competitive effect on oil, at least initially, and would be more likely to cut coal production and imports.

The chairman closed by thanking Mr Ion for his talk and members for their part in the discussion.

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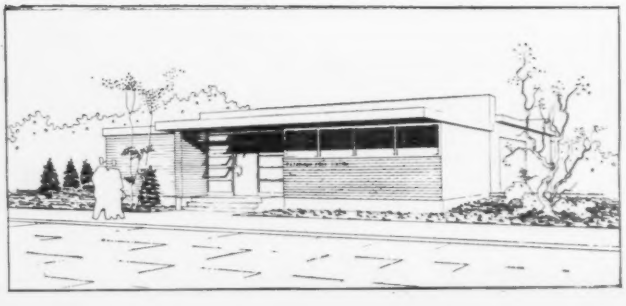


This petroleum field station of the Montana Bureau of Mines and Geology was opened recently during the annual meeting of the Rocky Mountain Section of the American Association of Petroleum Geologists. The station houses a permanent collection of cuttings and core samples from Montana wells which is available for inspection.

Royal Visit to the Kent Oil Refinery

On 5 April Her Majesty the Queen and His Royal Highness the Duke of Edinburgh paid a visit to the Kent Oil Refinery of the British Petroleum Company Ltd. Coincident with the arrival of the Royal party and the breaking of the Royal Standard over the refinery clock tower, the sun broke through an overcast sky and continued to shine throughout the visit. In stands erected at vantage points on the route through the refinery, hundreds of refinery employees and their families and friends were gathered to greet the Royal couple.

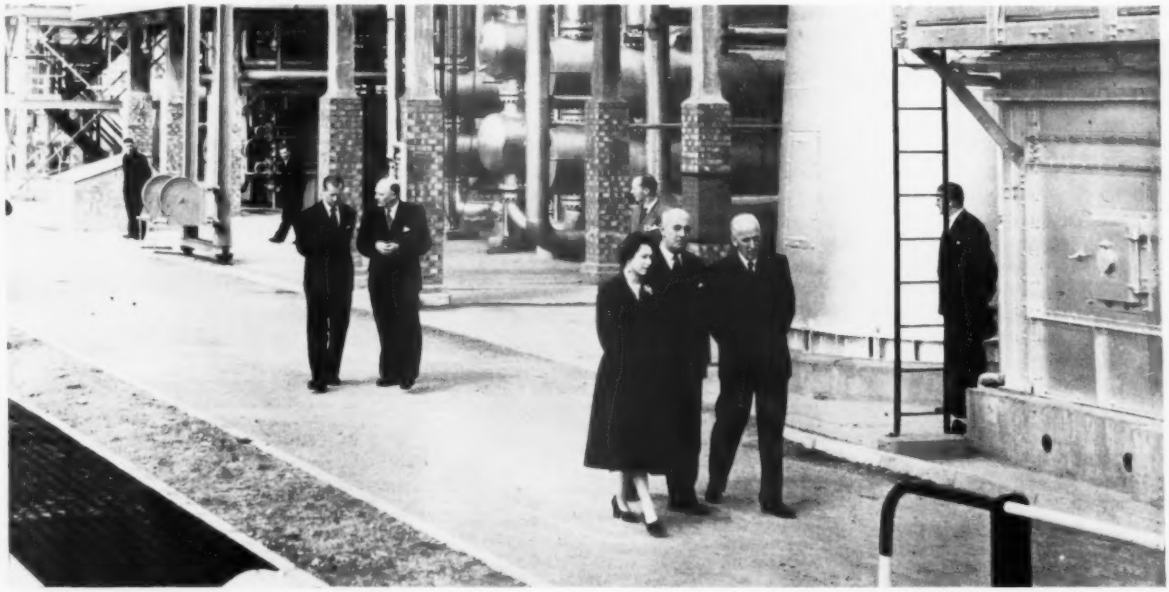
On their arrival at the entrance to the Administrative Building, Her Majesty and the Duke were received by the Lord Lieutenant of Kent (Lord Cornwallis) and Lady Cornwallis, who presented various local dignitaries. Then the chairman of The British Petroleum Co. Ltd., Lord Strathalmond, and Lady Strathalmond were presented and, at the entrance to the office building, C. S. Cleverley, general manager of Kent Oil Refinery Ltd., and Mrs Cleverley. Inside the building, the Directors of the British Petroleum Company were presented.

The Tour

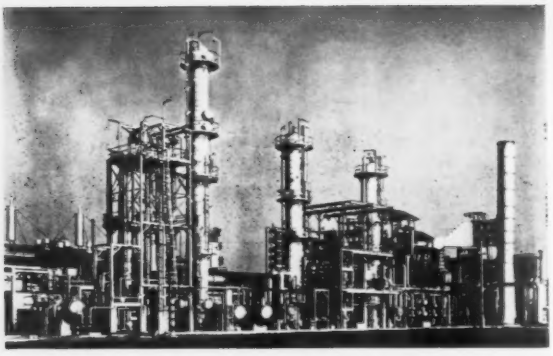
After a brief interval, the tour of the refinery by car and on foot commenced. On arrival at the Works Enclosure, the Queen graciously accepted a bouquet from Miss Denise Holland, ten-year-old daughter of C. Holland, a process operator. All major units and sections of the refinery were visited in turn and at various points members of the technical staff were presented.

On arrival at No. 7 jetty, Lord Strathalmond presented to Her Majesty and His Royal Highness, R. Gillespie, C.B.E. (managing director, British Tanker Co. Ltd.), Captain A. M. C. Goodwin (master, *British Princess*), L. A. Arkley (chief

The Queen, accompanied by Lord Strathalmond, chairman of British Petroleum Co. Ltd., and followed by The Duke of Edinburgh, passing one of the crowded stands in the Kent oil refinery.



H.M. The Queen leaving the Platformer accompanied by C. S. Cleverley, general manager, and Lord Strathalmond. Behind, the Duke of Edinburgh, is talking with A. Patrickson, works manager.



Among the units inspected by the Royal visitors was the newly-commissioned Platformer. Its capacity is 250,000 tons per annum.

engineer), and their wives. The *British Princess* was then inspected and it is recalled that this vessel was launched by The Queen, then Princess Elizabeth, at Sunderland in April 1946.

The party then proceeded to No. 6 jetty where the *British Sailor* was berthed. This vessel, launched in 1952, was the first of the British Tanker Company's series of thirteen 32,000 tonners and also represented the Company at the Coronation Naval Review at Spithead in June 1953. After the Master, Captain H. I. McMichael, O.B.E., and his wife, and Chief Engineer, G. W. Berryman, had been presented, the ship was inspected.

The royal party then returned to the general office for luncheon and later The Queen returned to London by car.

The Duke of Edinburgh, who had to travel to Chatham to open the new Medway College of Technology, chose a novel way of leaving the refinery. Waiting on the lawn behind the office building was a naval helicopter loaned to the Queen's Flight from Gosport. Immediately after escorting Her Majesty to her car, H.R.H. boarded the aircraft, which quickly took off on its journey to Fort Horsted.

H.R.H. The Duke of Edinburgh left the refinery by helicopter to keep another appointment in Chatham.

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Need for Science and the Humanities in British Industry

Problems facing British industry today were discussed by F. J. Stephens, a managing director of the Royal Dutch/Shell Group of oil companies, on the occasion of the launching of a new 18,000-dwt tanker, s.t.s. *Hemiplecta*.

The ceremony took place at the Birkenhead yards of Cammell Laird and Co. (Shipbuilders and Engineers) Ltd.

Mr Stephens began by thanking the sponsor, Lady Todd for acting as godmother to the new vessel, and went on to refer to the large amount of work carried out by Cammell Laird for the Royal Dutch Shell Group and its associates.

Mr Stephens then turned to some of the problems confronting British industry and said:

"We have all been told at various times by various politicians that if we are to survive in this island we must make more things and make them better and quicker and cheaper than our competitors. If there is to be an expansion in British trade it cannot be carried out by governments, by legislators, or by civil servants. The move has got to come from industry. Admittedly the governments, legislators, and civil servants can help with the industrial climate, but that is as far as they can go. For British industry to expand and be competitive we must attract brains and character, and in this we need all the help we can get from those institutions where brains and character are formed and developed."

What industry needed, said Mr Stephens, was "whole men"—if they were scientists they must feel and understand the place of the humanities in our way of life and work; if they were humanists, they must be capable of appreciating the scientific way of thought and the pattern of interwoven technical processes. They must know when the scientific could make its unique contribution to the formulation of plans for the future.

This was asking a great deal, said Mr Stephens. At one time the really cultivated man was generally as well up in the important developments of science as he was in those of art and literature. Things had changed since then for each subject in the field of science had opened up to such an extent that no man could have a thorough knowledge of all.

This led to "ultra specialization" of the science faculties at our leading universities, and even affected the schoolboy of 15½ to 16.

Mr Stephens summarized his view by saying "we must do everything in our power to increase the output of men trained in the applied sciences, but with a proper grounding of the fundamental sciences." Industry must be long-sighted, said Mr Stephens, and not try to wean away to the high positions and salaries in industrial science the men best fitted to hold academic posts. The interests of the universities and of industry in this problem of scientific manpower were mutual and their ways of tackling it must be complementary.

Around the Branches

BAHRAIN, FAWLEY, KUWAIT, LONDON, NORTHERN, SCOTTISH, SOUTH-EASTERN, SOUTH WALES, STANLOW, TRINIDAD

Bahrain Branch

The third ordinary meeting of the Bahrain Branch was held at Sitra Gate School, Awali, on 4 April. A total of 35 members and their guests attended to hear a talk by W. G. Windsor, Jr., on "The Construction of the Batangas Refinery".

After the minutes and announcements, the Chairman thanked members of the committee, which retired on 21 April, and in particular the Honorary Secretary, for their work during the past year.

Mr Windsor began his talk with a brief sketch of the Batangas scene as it appeared on his arrival before construction began. It was, he said, the most beautiful refinery location he had seen, with its bay surrounded by hills. The site had not, however, been chosen for its scenic beauty but for the shelter from typhoons, prevalent in the area, provided by the hills, and the ideal natural harbour for tankers. The rainy season was expected to be a major obstacle to construction work and a tight schedule was drawn up to complete site preparations—roads, drainage, foundations etc.—before the rains. Part of the local town had to be relocated and the sight of a low-bed truck carrying a complete house became commonplace.

Praise for Designers

Mr Windsor praised the designers of the refinery and the team of engineers on site, saying that no construction job in his experience had proceeded so smoothly and with so few major adjustments to original plans. An exciting diversion occurred in the form of a serious fire which threatened to destroy the local town. The construction equipment was moved in and with the emergency powers assumed by the local civil authorities, a fire break was cut, involving the demolition of many buildings. The courageous sacrifice, with the good work of the Caltex employees, saved much of the town. Another unwanted diversion was provided by the activities of the "Hukabes", an extreme political faction whose banditry made travel hazardous at times.

Praise was also due to the local labour, mainly Filipino, with whom there was no language difficulty as English had been taught for many years in the schools. A few ex-G.I.s had married Filipinos and settled in the country and a number of able Filipino graduates had been trained in Holland to fill responsible staff positions.

W. G. Miller then gave a most interesting impromptu discourse on Filipino politics, with particular reference to the rise of the "people's choice", the remarkable President Ramon Magsaysay, whose forthright integrity and courage have done so much for his country in recent times.

The Caltex film *Report from the Philippines*, featuring Batangas refinery and the opening day ceremonies in which the President played a leading part was then shown. A number of questions was answered before H. Greenough proposed a vote of thanks to Mr Windsor for his most enjoyable talk. The Chairman, in closing the meeting, thanked Bapco for the facilities provided.

The Chairman and Committee gave a party at House 7 on 13 April. Members and applicants and all who had in some way contributed to the Branch's activities during the past year were invited and more than 100 people attended.

Northern Branch

At a meeting of the Branch on 19 April a talk was given by A. B. Ashton on "Lubrication Requirements in Wiredrawing". Mr Ashton said that, fundamentally, wiredrawing consisted of pulling a cylinder of metal through a tapered hole whose smallest diameter was smaller than the starting

At the London Branch Fork Supper

W. H. Davies, the chairman of the London Branch, had every reason to be pleased with the success of this year's Fork Supper of the Branch. In the top left-hand picture he is seen with Mrs Davies, while in the right-hand top picture Jim Clark (left) and Ron Leach (right) member and secretary of the Committee respectively, appear to be equally satisfied. In the same picture the President is seen in a happy moment, while E. Thornton was a very welcome visitor from retirement in South Wales. The two bottom pictures indicate the happy spirit of the evening.

diameter of the cylinder. This had the effect of reducing the diameter and increasing the length of the wire. The piece of material in which the hole was made was called a wiredrawing die and the die was naturally a most important feature of wire production. From mediaeval to quite modern times dies were made of steel but eventually man managed to make holes of the required shape and size in diamonds which, of course, by virtue of their abrasion resistance, had much longer lives than steel dies. In the 1920s tungsten carbide was invented and this material rapidly replaced steel for dies which were too large to be made from diamonds.

Wiredrawing was originally a single-hole operation, the wire being pulled through one die at a time by a power-driven cylindrical block upon which the wire accumulated in a coil. The wire was drawn at quite slow speeds (*e.g.* 100 feet per minute) and its passage through the die was lubricated with vegetable oils or animal fats. Multi-die drawing, however, was duly invented and perfected and led to machines in which the wire was drawn in one operation through as many as twenty dies, successively.

This, Mr Ashton explained, was done by using a short cylindrical "capstan" after each die. The wire was threaded through the first die and taken round a capstan in four loops, which was sufficient to give a frictional grip on the wire which would pull it through the die. The wire was led from this capstan to, and through, the second die and looped again round the second capstan, and so on for as many times as there were dies in the machine. Since the wire was elongating at each draw the peripheral speeds of the capstans successively increased and, in modern machines, the final speeds reached were of the order of 5000–10,000 feet per minute.

It was impossible in practice, said Mr Ashton, to match precisely the elongation of the wire with the speed increases of the capstans, and peripheral slip of the wire on the capstans therefore occurred. Furthermore, there was lateral slip also, since the oncoming wire must push sideways the turns of wire already round the capstan. There was, therefore, considerable friction between wire and capstan all the time the machine was running.

The amount of heat generated in high-speed drawing was very considerable. It was generated by friction in the drawing dies and on the capstans but these two sources were augmented by heat arising from internal friction in the metal itself. A dominant necessity therefore was cooling and lubricants were used which were coolants first and lubricants second.

Present lubricating practice, said Mr Ashton, consisted of flooding the whole machine with a water suspension of emulsifiable oils, fats, or metallic soaps. The concentration of the emulsion was generally between 3 and 5 per cent by volume. This mixture was liberally sprayed by pressure jets on to all the dies and capstans and the machines contained up to 300 gallons of it according to their size.

It was, of course, important that the lubricant should have no deleterious effects on the final drawn wire and many good lubricating materials were barred for this reason; sulphur compounds for instance could not be used with copper as they produced sulphide staining.

The wire drawer would like lubricants which would prolong the life of drawing dies since worn dies caused machine stoppages which interfered with production. The conditions of speed, temperature, and pressure, however, were very arduous and improvements in lubricants would no doubt be difficult to achieve. They would, however, be very welcome if they could be attained.

South-Eastern Branch

On 5 April members assembled at the King's Head Hotel, Rochester, to hear A. Chatting, chief electrical engineer of E. B. Badger and Sons, Ltd., present a paper on "Electricity in Hazardous Atmospheres". Mr Chatting is well known to the Branch and needed no introduction, having been the Branch Treasurer during the first three years of the Branch's life.

Mr Chatting delivered his talk in two parts, dealing firstly with the basic principles of electricity and power generation. He explained how each of the seemingly complicated pieces of electrical equipment found in a refinery had a parallel in the field of general engineering practice, switchgear for instance might be likened to a stop valve and a transformer to a pressure-control valve.

Mr Chatting went on to explain, with the aid of lantern slides, the function of the different types of flameproof equipment employed in the oil industry. All flameproof equipment was designed, he said, to withstand the forces of an internal explosion without disintegrating or allowing flames to pass out of the chamber—the latter function being achieved by providing the equipment with heavy metal flanges and maintaining the joint clearances to such fine limits that any flame would be quenched before reaching the outer atmosphere.

At the conclusion of the talk H. C. Carter proposed a vote of thanks to Mr Chatting for presenting a difficult subject in such an interesting manner.

After refreshments, the meeting was brought to a close with the showing of the film *The Diesel Story*.

Stanlow Branch

At a meeting of the Branch held at the Grosvenor Hotel, Chester, on 16 March, a paper by W. A. Keightly of Universal Oil Products Co. on "Platforming of Middle East Naphthas" was presented. In the absence of the author, the paper was read by E. W. Schnabel of the same organization.

Platforming of Middle East naphthas is now being carried out in twelve countries by 24 units having a combined capacity of 152,000 b.s.d. Of these, 12 are primarily designed for aromatics production while the remainder are directed toward gasoline manufacture.

As a preliminary step to Platforming, feed preparation is carried out, with the dual object of, by distilling, removing dissolved oxygen and oxygenated compounds, which can lead to fouling, and also of stripping off light ends which, by virtue of their intrinsic high octane number, cannot be appreciably improved by Platforming. Feed preparation can be avoided if the atmospheric distillation unit supplies the Platformer direct or if any intermediate storage is in gas-blanketed or floating-roof tanks.

The catalyst is maintained in fixed beds in the reactors, operating temperatures are 450°–525° C with pressures of 200 to 1000 p.s.i. An equilibrium is established between hydrogen recycle and the carbon-forming deposit, which is being continuously laid down on the catalyst and removed by hydrogen recycle. Sulphur compounds in the feed are removed, in the form of H_2S, from the recycle gas by an amine scrubber. Catalyst life varies with the feedstock and operating severity. It can be as high as 250 brl/lb, the average figure being 75 brl/lb.

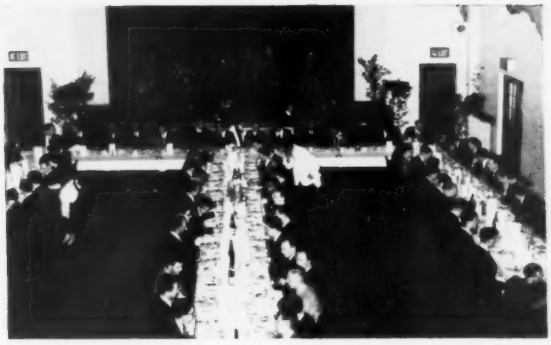
Gas yields vary with conditions, a typical figure is 600 cu. ft./brl of hydrogen and 110 cu. ft. of methane and ethane.

When operating on Wafra, Iraq, Kuwait, or Arabian naphthas of about 120°–250° C, and at a 90 F1 clear level for the product, yields are 88–91 per cent.

Operating costs were discussed in Mr Keightly's paper; on the basis of a 1000-b.s.d. unit, typical values are (cents per brl) catalyst 9, utilities 10–15, operating labour 4–5, which with taxes, insurance, and maintenance brings the total cost to 30–39. As regards investment cost a representative figure is 200–300 $/brl.

The discussion was opened by W. F. Smith of Shell Refining and Marketing Co. Ltd.

Birmingham Students' Dinner



Guest of honour at the Eighth Annual Dinner of the Birmingham University Chemical Engineering Society and Student Section of the IP, was A. S. White, head of the Chemical Engineering Department of the AERE, Harwell. The general theme of the evening was "Nuclear Engineering", and the dinner, which was held on 4 May, was presided over by J. R. S. Morris, chairman of the Society. Altogether over 200 students and guests participated, the guests including Lt.-Col. S. J. M. Auld, IP President, E. J. Dunstan and E. C. Masterson, members of IP Council, and Dr Robert Aitken, Vice-Chancellor of the University.

The toast of the evening, "Nuclear Energy", was proposed by Professor F. H. Garner, O.B.E., professor of chemical engineering and a past-president of the Institute. He said it was wrong to commiserate with youth on account of the difficult times in which they lived. It was precisely in such times that there were the greatest opportunities.

The Department of Chemical Engineering was within a short time of occupying its new building and Professor Garner hoped that their new biological section would soon be started. Future plans included a post-graduate course on that aspect of chemical engineering and an advanced course in chemical engineering itself, both leading to an M.Sc. degree.

Replying to the toast, A. S. White, head of the chemical engineering department at Harwell, said that the military aspects of nuclear energy were rapidly giving place to civil aspects. For example, at the Geneva conference in August the extent to which information would be freely available would, he believed, surprise professional men in other fields. Calder Hall, England's first generating station, was a modest start to a programme which might well be producing 1500-2000 megawatts within ten years.

This rapid growth would require a steady addition to the professional men in nuclear engineering. The essential part of the training of an engineer was a sound grounding in the fundamental sciences and in their application. He thought that nuclear engineering must be a post-graduate study. The two broad requirements were concerned with processes and with reactor design.

At present the Reactor School at Harwell provided post-graduate training primarily for men already in industry, but it should not be long before universities were running courses. Nuclear engineering was not a primary technology and Mr White felt that the best basic training was given in chemical engineering.

The Guests

The toast of "The Guests" was proposed in appropriate manner by H. Crocker, student treasurer of the Society, and replied to by Lt.-Col. S. J. M. Auld, president of the Institute of Petroleum, who felt that the great successes of the oil industry and particularly its wonderful latter-day synthetic development were the justification of the organic chemist.

He wondered whether the oil world was doing everything it could to foster the accumulation of fresh data about petroleum. Birmingham was one of the few centres of such enlightenment. Through the IP its message had gone out to the industry, and to the research centres and to other universities

At the dinner of the Birmingham Students the toast of "Nuclear Engineering" was proposed by Professor F. H. Garner (extreme left), and replied to by A. S. White (left).

(Right) J. R. S. Morris replying to the toast of "The Society" at the Annual Dinner of the Birmingham University Chemical Engineering Society, and (far right) H. Crocker, proposing the toast of the guests.

and schools. More knowledge was wanted of the nature of the contents of Pandora's petroleum box. We could then hope to build up an ever-increasing structure of good from this great gift of oil to humanity. It was only when we knew more about the hydrocarbons of petroleum that we could hope to develop fresh hypotheses which would lead us on. To what? Through basic research to applied chemistry and thence to process development and thereby to national and international pre-eminence in the petroleum world.

The chemical engineer had indeed elaborated instruments of precision to measure and improve process efficiency. But was he not condemned by our chemists' lack of knowledge, or at any rate limited knowledge, to remain in the hammer and chisel stage of shaping petroleum to our needs? Mostly he was left to manhandle the hydrocarbons.

We could only hope that before all our oil was burnt we should know more of what it was made.

The Chemical Engineering Department was fortunate, said Lt.-Col. Auld, in having at its head men of determination. The basic research into the composition of petroleum which had been fostered by Professor Garner and guided by Professor Morton must be supported and still further encouraged by the petroleum and chemical industries. The Institute of Petroleum would do everything in its power to that end. He concluded by saying that it was a fine thing to be able to claim Birmingham as one's alma mater and an equally grand thing to be able to say "I was a Garner man", or "I studied under Morton". These were hall marks, and he commended them to preserve them.

The Society

Proposing the toast of "The Society", H. W. Cremer, O.B.E., said that chemical engineers had had difficult times in Britain but had now emerged triumphant. The new departments of chemical engineering now being formed showed that no longer were excuses necessary for being chemical engineers. The fact that the foundation of a chemical engineering department was always followed by the foundation of a society was a most significant feature. The modern student found time to indulge in social activities and sport, and these were a very important part of university life.

J. R. S. Morris, chairman of the Society replied.

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Institute of Petroleum ASTM/IP Tables in Handy Volumes

The ASTM/IP Petroleum Measurement Tables published jointly by the two associations in 1952 and 1953 are now recognized all the world over as the authoritative tables to be used in the accurate computation of bulk quantities of petroleum products. In the last two years requests have been received for the tables in sectional and easily-handled form for day-to-day use in refineries, and more particularly in small installations and oil depots. Such separate tables taken from the American Edition are already available from the ASTM in a series of paper-covered volumes.

In the case of the two volumes—British and Metric—published by the IP, much consideration has been given to the contents of the sectional volumes which are shortly to be made available.

Details of the breakdown of the two volumes are given below. It will be seen that an attempt has been made to meet the needs of the smaller installations and depots by making available to them the minimum number of booklets of tables which will meet their requirements in respect of the particular products which they handle and the units of measurement in which they work.

The British Tables

From the British Edition seven separate paper-covered sectional volumes are being prepared and are expected to be available in early August. These are:—

Vol. A. *Interrelation of Units, Gravities and Density and Volumes* (28 pages)

Table 1. Interrelation of Units of Measurement.
Table 3. API Gravity at 60°F to Specific Gravity 60/60°F and to Density at 15°C.
Table 21. Specific Gravity 60/60°F to API Gravity at 60°F and to Density at 15°C.
Table 22. U.S. Gallons at 60°F, Barrels at 60°F and Imperial Gallons at 60°F to Litres at 15°C against Specific Gravity 60/60°F.
Table 51. Density at 15°C to Specific Gravity 60/60°F and to API Gravity at 60°F.
Table 52. U.S. Gallons at 60°F and Imperial Gallons at 60°F per Litre at 15°C, Barrels at 60°F per 1000 Litres at 15°C against Density at 15°C.

Vol. B. *Weights Per Unit Volume and Volumes Per Unit Weight Against SP.GR. 60/60°F* (52 pages)

Table 1. Interrelation of Units of Measurement.
Table 26. Pounds per U.S. Gallons at 60°F and U.S. Gallons at 60°F per Pound against Specific Gravity 60/60°F.
Table 29. Long Tons per 1000 U.S. Gallons at 60°F and per Barrel at 60°F against Specific Gravity 60/60°F.
Table 30. U.S. Gallons at 60°F and Barrels at 60°F per Long Ton against Specific Gravity 60/60°F.
Table 31. Litres per 15°C per Short Ton and per Long Ton against Specific Gravity 60/60°F.
Table 36. Pounds per Imperial Gallon at 60°F against Specific Gravity 60/60°F.
Table 37. Long Tons per 1000 Imperial Gallons at 60°F against Specific Gravity 60/60°F.
Table 38. Imperial Gallons at 60°F per Long Ton against Specific Gravity 60/60°F.
Table 39. Long Tons per 1000 Cubic Feet at 60°F against Specific Gravity 60/60°F.
Table 40. Long Tons per Water Ton at 60°F against Specific Gravity 60/60°F.
Table 41. Metric Tons per 1000 Imperial Gallons at 60°F against Specific Gravity 60/60°F.

Vol. C. *Reduction of Observed Specific Gravity and Volume to 60°F For LPG and Casinghead Gasoline* (96 pages)

Table 23. Reduction of Observed Specific Gravity to Specific Gravity 60/60°F (for Range 0·420 to 0·749).
Table 24. Reduction of Volume to 60°F against Specific Gravity 60/60°F (for Range 0·500 to 0·720).
Table 25. Reduction of Volume to 60°F (Abridged Table) against Specific Gravity 60/60°F.

Vol. D. *Reduction of Observed Specific Gravity and Volume to 60°F For Aviation Gasoline, Motor Gasoline, Kerosine, and Gas Oil* (128 pages)

Table 23. Reduction of Observed Specific Gravity to Specific Gravity 60/60°F (for Range 0·640 to 0·899).
Table 24. Reduction of Volume to 60°F against Specific Gravity 60/60°F (for Range 0·690 to 0·870).
Table 25. Reduction of Volume to 60°F (Abridged Table) against Specific Gravity 60/60°F.

Vol. E. *Reduction of Observed Specific Gravity and Volume to 60° F For Diesel Fuel and Fuel Oils* (152 pages)
Table 23. Reduction of Observed Specific Gravity to Specific Gravity 60/60° F (for Range 0·820 to 1·049).
Table 24. Reduction of Volume to 60° F against Specific Gravity 60/60° F (for Range 0·840 to 1·020).
Table 25. Reduction of Volume to 60° F (Abridged Table) against Specific Gravity 60/60° F.

Vol. F. *Reduction of Observed Specific Gravity and Volume to 60° F For Fuel Oils and Bitumen* (148 pages)
Table 23. Reduction of Observed Specific Gravity to Specific Gravity 60/60° F (for Range 0·890 to 1·099).
Table 24. Reduction of Volume to 60° F against Specific Gravity 60/60° F (for Range 0·960 to 1·100).
Table 25. Reduction of Volume to 60° F (Abridged Table) against Specific Gravity 60/60° F.

Vol. G. Table 24. Reduction of Volume to 60° F against Specific Gravity 60/60° F (88 pages).

Metric Tables

In the case of the Metric Edition it has been decided to produce five Sectional Volumes, their contents being as follows:—

Vol. H. *Miscellaneous Metric Tables* (48 pages)
Table 1. Interrelation of Units of Measurement.
Table 51. Density at 15° C to Specific Gravity 60/60° F and to API Gravity at 60° F.
Table 52. U.S. Gallons at 60° F and Imperial Gallons at 60° F per Litre at 15° C, Barrels at 60° F per 1000 Litres at 15° C against Density at 15° C.
Table 56. Kilograms per Litre at 15° C and Litres at 15° C per Metric Ton against Density at 15° C.
Table 57. Short Tons and Long Tons per 1000 Litres at 15° C against Density at 15° C.
Table 58. U.S. Gallons at 60° F, Barrels at 60° F and Imperial Gallons at 60° F per Metric Ton against Density at 15° C.

Vol. I. *Reduction of Observed Density and Volume to 15° C. For LPG and Casinghead Gasoline* (120 pages)
Table 53. Reduction of Observed Density to Density at 15° C (for Range 0,420 to 0,759).
Table 54. Reduction of Volume to 15° C against Density at 15° C (for Range 0,500 to 0,720).
Table 55. Reduction of Volume to 15° C (Abridged Table) against Density at 15° C.

Vol. J. *For Aviation Gasoline, Motor Gasoline, Kerosine and Gas Oil* (148 pages)
Table 53. Reduction of Observed Density to Density at 15° C (for Range 0,650 to 0,899).
Table 54. Reduction of Volume to 15° C against Density at 15° C (for Range 0,690 to 0,870).
Table 55. Reduction of Volume to 15° C (Abridged Table) against Density at 15° C.

Vol. K. *For Diesel Fuel and Fuel Oils* (196 pages)
Table 53. Reduction of Observed Density to Density at 15° C (for Range 0,810 to 1,049).
Table 54. Reduction of Volume at 15° C against Density at 15° C (for Range 0,840 to 1,020).
Table 55. Reduction of Volume to 15° C (Abridged Table) against Density at 15° C.

Vol. L. *For Fuel Oils and Bitumen* (184 pages)
Table 53. Reduction of Observed Density to Density at 15° C (for Range 0,890 to 1,099).
Table 54. Reduction of Volume to 15° C against Density at 15° C (for Range 0,960 to 1,100).
Table 55. Reduction of Volume to 15° C (Abridged Table) against Density at 15° C.

Availability and Cost

These sectional volumes will be available from the offices of the Institute only at the following prices, which indicate the reductions for quantities of 10 copies or over of any one volume:—

Vol.	*Price per copy, post free*		
	First 25	*Second* 25	*After first* 50
	s. d.	*s. d.*	*s. d.*
A	2 0	1 9	1 6
B, H	3 6	3 3	3 0
C, G	5 0	4 6	4 0
D, I	6 0	5 6	5 0
E, F, J	6 6	6 0	5 6
K, L	7 6	7 0	6 3

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Trade Literature

Device for Handling Heat Exchanger Bundle Tubes

A new hydraulic handling device is now being produced by The Fabricated Products Division of The M.W. Kellogg Company for use in removing and replacing heat exchanger bundle tubes. The new device eliminates the need for rigging and pulling beams and can be operated by two men to push a bundle eight feet in less than 25 minutes.

Known as the Hydro-ejector, the new device is available as a complete packaged unit. It is said to be so accurate in alignment that even the largest bundles will not stick when moved rapidly with the 12,000-lb force which can be exerted by the device.

Hand-operated Dispensing Pump

A type 10-C one-gallon, hand-operated pump for dispensing petrol, fuel oil, kerosine, etc., has been added to the range of equipment available from Liquid Systems Ltd.

The pump is designed so that it can be fitted to a flat rectangular container and mounted on a lorry as well as being used in the normal way with an underground storage tank.

New Hose for Petroleum Products

A new light-weight, flexible suction and delivery hose for handling petrol, oil, pure benzole and other chemicals, etc., has been produced by the Compoflex Co. Ltd. The new hose is available in a range of bore sizes up to four inches and the weight per foot varies from 0·65 lb for 1½-inch diameter hose to 2·9 lb for 4-inch diameter hose.

An example of the advantages of using this hose, apart from ease of handling, is that a road tanker fitted with the new hose can carry up to 60 lb more fuel per journey.

New Flowmeter

An instrument for the measurement by differential pressure of the flow of water, steam, oil, air, gas, etc.—the Commander K U flowmeter—has been produced by George Kent Ltd. of Luton, Bedfordshire. A feature of the new instrument is that interchangeable unit construction makes it possible to assemble a variety of instruments from standard units.

George Kent Ltd. has also recently produced a new illustrated brochure giving details of the Company's instruments and services.

A reflectoscope in use at the Power Piping and Sprinkler Division plant of the Blaw-Knox Company, Pittsburgh. This ultrasonic machine is used to measure wall thicknesses in pipe sections which are ordinarily inaccessible. It is also used to detect internal flaws in the metal of the pipes.

The IP Council and Officers 1955-56

The nomination of Lt.-Col. S. J. M. Auld, O.B.E., M.C., D.Sc., as President of the Institute for a further term was unanimously agreed by the members at the Annual General Meeting on 21 April 1955.

Colonel Auld was first elected to the Council in 1932 and in 1935 became a vice-president. In 1937 he was elected as President and served in that position for two sessions until 1939. He was again elected President in 1954.

In 1919 he joined the Anglo-Persian Oil (now British Petroleum) Company and spent some nine years on refinery and field work in Persia and in Burma. Then followed eighteen years with Socony-Vacuum Oil Company Inc. and with the Vacuum Oil Company Ltd. In 1946 Colonel Auld retired from the post of Chief Technologist to Vacuum and since then has been a director of American Locomotive Export Co. Inc. and other companies.

During both world wars Colonel Auld served with distinction. In the 1914-18 conflict he served first with the Royal Berkshire Regiment, then with the Royal Engineers, and later became Chemical Adviser to the Third Army. He commanded the British Gas Warfare Mission to the U.S.A., served with the American Army in the Argonne, and was awarded the American Distinguished Service Medal.

In world war II he was one of the technical advisers to the Petroleum Board and chairman of the Technical Committee of the Lubricating Oil Pool, as well as of the Technical Sub-Committee of the War Cabinet Committee and of the Enemy Oils and Fuels Committee. He was also an adviser on flame projectors to the Petroleum Warfare Department.

Colonel Auld is also the Honorary Treasurer of the Permanent Council of the World Petroleum Congress and a Vice-President of the Fourth World Petroleum Congress as well as chairman of the British National Committee.

Vice-Presidents

At the same meeting, three new Vice-Presidents of the Institute were unanimously elected as follows:

E. B. Evans, M.Sc., Ph.D., F.R.I.C., who was first elected to the Council in 1939, has served as a Vice-President on two previous occasions—1948-50 and 1951-54. In 1946 Dr Evans was appointed Honorary Associate Editor and Deputy Chairman of the Publications Committee, of which he had been a member since 1939. In 1955 he succeeded to the Honorary Editorship. In addition to these activities, he serves and has served on many other Council committees, including the Standardization Committee and the Hydrocarbon Research Group, of which he was a member and honorary secretary from 1944 to 1947.

It was in 1926 that Dr Evans first joined the Anglo-American Oil (now Esso Petroleum) Company as a chemist, first at the Purfleet installation, then at the Vauxhall laboratories, and later in the Technical Sales Department. Seconded to the Chemical Department of the Petroleum Board at the beginning of the war, he returned to his company in 1945 and, on the formation of the Esso Development Company Ltd. shortly later, was transferred to that Company to become its chief chemist in 1950.

A. C. Hartley, C.B.E., F.C.G.I., B.Sc.(Eng.), has been a member of the Council since 1934 and served previously as a Vice-President from 1942 until 1948. He is also a member of various committees and was chairman of the Engineering Committee from 1937 until 1948.

Mr Hartley retired as chief engineer of the Anglo-Iranian Oil Company Ltd. in 1951, having held that post since 1934 and having been with the Company since 1924. He is now consultant to Rendel, Palmer and Tritton, consulting civil engineers, and a director of Johnson and Phillips, electrical engineers.

During the second world war, Mr Hartley became associated with the development of aircraft armament equipment in 1940 and from 1942 until 1945 was Technical Director of the Petroleum Warfare Department. In this position he was responsible for the development of the PLUTO cross-channel pipeline and for the FIDO airfield fog clearance system. For the latter and similar work he was awarded the C.B.E. in 1944 and in 1946 the U.S. Army Medal with Bronze Palm.

E. J. Sturgess, B.Sc., was first elected to the Council in 1948 and in the same year took over the chairmanship of the Engineering Committee, which he still holds.

Following apprenticeship at Marshall and Sons, of Gainsborough, he joined Asiatic (now Shell) Petroleum Company in 1925 and served in Singapore until 1937. On returning to England he joined the Company's London office, and in 1947 became chief engineer, his present position.

During the second world war Mr Sturgess was closely connected with the construction of the U.K. pipelines and also with the installation of FIDO at various airfields.

Council

This year there were twelve vacancies on the Council for which there were fifteen nominations. Two new members were elected, N. W. Grey and T. W. Mathias. H. Hyams and R. B. Southall, retiring Vice-Presidents, were elected members of Council and eight members of Council were re-elected. They were: V. Biske, E. J. Dunstan, F. L. Garton, A. J. Goodfellow, E. C. Masterson, J. S. Parker, A. R. Stark, and W. H. Thomas.

N. W. Grey, M.Inst.Chem.E., F.Inst.Pet., is one of the two newly elected members of Council. Born at Maidstone and educated at the Medway Technical College and the Regent Street Polytechnic, Mr Grey spent 12 years supervising the operation and maintenance of refinery plant in South America and four years with the Celanese Corporation of America as supervising chemical engineer on the design and operation of petrochemical plants. For the last 10 years Mr Grey has been engaged by the British Petroleum Co. Ltd. on the development and construction of various projects, including Grangemouth and Kent Refineries.

Mr Grey is founder Chairman of the South Eastern Branch. He has also been an *ex officio* member of Council representing that Branch ever since its formation.

T. W. Mathias, O.B.E., M.A., M.Inst.T., General Manager —Operations, Shell-Mex and B.P. Ltd., and a Fellow of the Institute since 1948, is the second new member of Council.

Educated at Lausanne, St. Pauls School, and Merton College, Oxford, from where he graduated with an Honours Degree in Natural Sciences, he served in the first world war in Germany and France, holding a commission in the Royal Garrison Artillery.

After taking his degree he took a position as analytical chemist in the Shell Central Laboratories and later specialized in bitumen. In 1935 he was appointed sales manager of Colas Products Ltd., and became managing director of that Company in 1941. Upon dissolution of the Petroleum Board in 1948, Mr Mathias was appointed manager of the Bitumen Department of Shell-Mex and B.P. Ltd., in succession to the late J. S. Killick, and on 1 April 1951 he was appointed to his present position.

He was awarded an O.B.E. in the Birthday Honours in 1954.

As *ex-officio* members of Council to represent the Branches, the following were nominated and elected unanimously: S. A. Berridge (Fawley Branch), W. H. Davies (London Branch), G. M. Davies (Northern Branch), W. M. Stirling (Scottish Branch), A. S. Brooman (Stanlow Branch), J. R. Moore (South-Eastern Branch).

Honorary Officers

G. H. Coxon (The British Petroleum Co. Ltd.) was unanimously re-elected as Honorary Treasurer, and C. Chilvers (Esso Petroleum Co. Ltd.) as Honorary Secretary.

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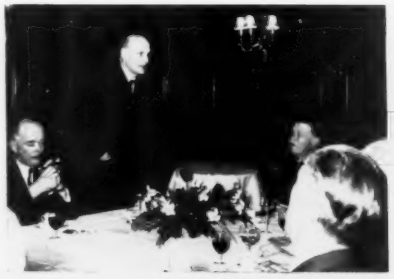

Professor Weiss at the Council Dinner

Following the Annual General Meeting the Council held an informal dinner, the guest of the evening being Professor H. Weiss, Emeritus Professor at Strasbourg and now of the Office Nationale de l'Université de l'Ecole Française. Following the dinner he addressed the company and in the top left-hand picture is seen doing so. In the top right-hand picture are (l. to r.) E. C. Masterson; H. Hyams; Professor Weiss; Lt.-Col. S. J. M. Auld, President; Dr E. B. Evans; J. S. Parker; W. H. Davies; A. J. Ruthven-Murray.

In the lower photograph we have C. Chilvers, Honorary Secretary; D. L. Samuel; E. C. Masterson; T. Dewhurst, Past-President; and F. L. Garton, while in the right-hand bottom picture the Chairman of the Publications Committee, Dr Evans, is second from the left with, to his right, D. L. Samuel, Chairman of Papers Sub-Committee and J. S. Parker, Chairman of Publications Costing Sub-Committee, with the Editor to the left of Dr Evans.

U.K. Petroleum Consumption and Refinery Production

Continued Increases in 1954

Over 20 million tons of petroleum products (excluding bunkers for ships in the foreign trade) were consumed in the United Kingdom during 1954. According to figures published recently by the Petroleum Information Bureau on behalf of the U.K. Petroleum Industry Advisory Committee, inland consumption during 1954 totalled 21,038,511 tons—over two million tons more than the figure for 1953.

Consumption of gas, diesel, and fuel oils has outstripped that of motor spirit and is now the largest item in the table of consumption. Steel manufacture and steam-raising furnaces each used 1¼ million tons of these products and over 600,000 tons were used for central heating. Over 50 per cent more gas oil was used for agricultural tractors, with a resultant decline in the consumption of kerosine. An increase in the amount of oil used in making gas reflects the expansion in this direction during 1954.

Motor spirit—now the second largest item of consumption—amounted to 5,920,000 tons—an increase of 3 per cent on the figure for 1953. Demand was divided between premier grades (2,820,000 tons) and standard grades (3,100,000 tons).

Nearly 64 per cent of all petrol sold through garages consisted of premier grades and commercial consumers also used more premier and less standard grade motor spirit.

Deliveries of motor spirit to commercial users were, however, below the figure for 1953 as a result of the increase in diesel-engined vehicles.

TABLE I
U.K. PETROLEUM PRODUCTS CONSUMPTION

	1953 *Tons*	1954 *Tons*
Motor spirit (incl. motor benzole):		
Dealers: Premier grades	2,197,254	2,532,676
Standard grades	1,578,260	1,451,522
Commercial consumers:		
Premier grades	255,378	289,381
Standard grades	1,709,063	1,648,829
Industrial spirits (incl. industrial benzole)	100,917	121,180
White spirit	140,998	147,967
Kerosine		
Burning oil	546,708	603,977
Vaporizing oil	833,051	706,940
Derv fuel	1,270,773	1,413,207
Gas, diesel, and fuel oils:		
Burning	3,550,845	4,121,870
Power	1,330,332	1,467,193
Gas and other manufacture	502,820	604,115
Refinery consumption	1,508,491	1,923,062
Petroleum industry's own use	148,468	159,057
Lubricating oils and greases	794,238	845,179
Paraffin wax and scale	40,053	46,254
Propane and butane	53,164	58,768
Bitumen	749,526	807,558
Other products (mainly aviation fuels and chemical feedstocks)	1,692,356	2,089,776

Increased industrial activity was reflected in an increase of 6 per cent in the consumption of lubricants and there was also an increase in the use of bitumen. Details extracted from the P.I.B. figures are given in Table I.

Table II shows an increase of almost three million tons in the production of refined products in the U.K. in 1954 compared with the figure for 1953. Taken together, Tables I and II show that there was an appreciable excess of production over consumption for a number of products, with resultant benefit in terms of export earnings.

TABLE II
U.K. PRODUCTION OF PETROLEUM PRODUCTS EX IMPORTED AND INDIGENOUS CRUDE AND PROCESS OILS (INCL. SHALE)

	1953 *Tons*	1954 *Tons*
Motor and aviation spirit	6,243,355	7,124,514
Industrial spirits	2,384	2,316
White spirit	45,126	106,229
Burning oil	472,971	680,256
Vaporizing oil	80,334	67,308
Gas (diesel oil)	4,303,935	4,191,809
Fuel oil	10,747,120	11,369,258
Refinery fuel consumption (ex own production)	1,494,646	1,906,938
Bitumen	715,887	809,154
Paraffin wax, scale, and slack wax	15,217	16,855
Lubricating oil	365,891	588,496
Propane and butane	48,309	54,107
Miscellaneous products and loss	860,784	1,160,525
TOTAL	25,395,959	28,077,765

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CRUDE OIL PRODUCTION

	1955 *March*	*Jan. to Mar.*
	Tons	
Qatar Petroleum Co. Ltd.	446,917	1,259,731
Kuwait Oil Co. Ltd.	4,552,335	12,907,048
Iraq Petroleum Co. Ltd.	2,005,632	5,786,594
Basrah Petroleum Co. Ltd.	588,942	1,557,617
Mosul Petroleum Co. Ltd.	117,147	321,532
	April	*Jan. to April*
	Brl	
Kern Oil Co. Ltd.:		
California	101,606	
Trinidad	77,437	
	Tons	
Qatar Petroleum Co. Ltd.	436,323	1,696,054
Kuwait Oil Co. Ltd.	4,781,033	17,688,081
Iraq Petroleum Co. Ltd.	1,971,530	7,758,124
Basrah Petroleum Co. Ltd.	641,873	2,199,490
Mosul Petroleum Co. Ltd.	104,315	425,847

Shell-Mex and BP New Tankers

"BP Haulier" and "Shell Welder"

Launched on 22 April from the Faversham shipyard of James Pollock Sons and Co. Ltd. by Mrs Haygarth, wife of C. H. S. Haygarth, managing director of Pump Maintenance Ltd. and formerly deputy general manager of Shell-Mex and B.P. Ltd., *B.P. Haulier* is the first of a fleet of similar vessels being built for the latter Company.

These vessels are intended for work in estuaries around Britain and have been designed to embody new features enabling maximum cargoes to be carried in limited waterways complicated further by acute bends.

Thus, *B.P. Haulier* is the first tanker built in Britain to be propelled by a Voith Schneider cycloidal propeller, a device which eliminates the need for rudder mechanism.

The Voith Schneider propeller consists of a number of vertical blades of aerofoil section rotating around a vertical axis. Only the blades project beyond the hull, all the other parts of the propeller being accommodated inside. A mechanism inside the hull transmits a feathering action to the blades which produce the "thrust". The blade motion can be changed so that either the magnitude of the "thrust" in the lengthwise direction is altered or reversed, or the full "thrust" or part of it acts athwartships, while the speed and direction of "rotation" of the propeller remains unaltered.

Believed to be the largest tanker built in Kent, the vessel is of 300 tons carrying capacity and, being double-skinned, is designed to meet PLA and Lloyds requirements for carriage of petroleum on the Thames. Her main dimensions are:

Length overall	148 ft
Length B.P.	140 ft
Beam moulded . . .	27 ft 6 in
Depth moulded . . .	8 ft 6 in
Draft loaded	5 ft 6 in

The Faversham depot of Shell-Mex and BP Ltd. from which the B.P. Haulier *will operate to refineries on the Medway and Thames.*

Mrs C. H. S. Haygarth, with Mr Haygarth, performs the launching ceremony.

Main engine is a Lister-Blackstone EVMC6 oil engine rated at 270 b.h.p. at 600 r.p.m. and operating through a modern wheel-drive oil-operated isolating clutch to the propeller. The main crankshaft is extended forward to drive, through a friction clutch and vee belts, two Stothert and Pitt screw displacement cargo pumps.

Two auxiliary sets, each powered by a Lister Type 2JPMA engine rated at 18 b.h.p. at 1000 r.p.m., are provided. One will drive a Lancashire Dynamo and Crypto 10-kW, 110-V, D.C. generator. The other will drive a Hamworthy Type 2SM3 compressor for starting the main engine, and a Hamworthy D2 centrifugal pump, having a 30-ton-per-hour output, for general duties.

Engine controls are by the Bloctube principle, led to the navigating bridge amidships and to the pump room aft.

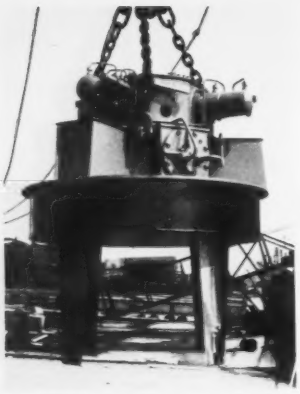
The vessel has four tank compartments and the two cargo pumps are coupled to independent suction lines arranged to ensure isolation of products carried.

M.V. "Shell Welder"

An interesting Shell-Mex and B.P. coastal tanker is the *Shell Welder*, which was launched in November 1954 and took on board her first cargo at Shell Haven at the end of March.

The main feature of this 586-dwt vessel is that three different forms of anti-corrosion measures have been introduced to the cargo tanks.

Tank No. 1. This tank will be protected internally with an "Epikote" resin-based coating. This range of synthetic resins has been developed by Shell and can be cured at between 60° and 140° F, temperatures easily obtainable by



The Voith Schneider cycloidal propeller with which B.P. Haulier *has been fitted.*

hot air. As tank linings, "Epikote" resins have been used in other tankers of the Shell fleet, but *Shell Welder* is the first tanker in Britain to have this protection.

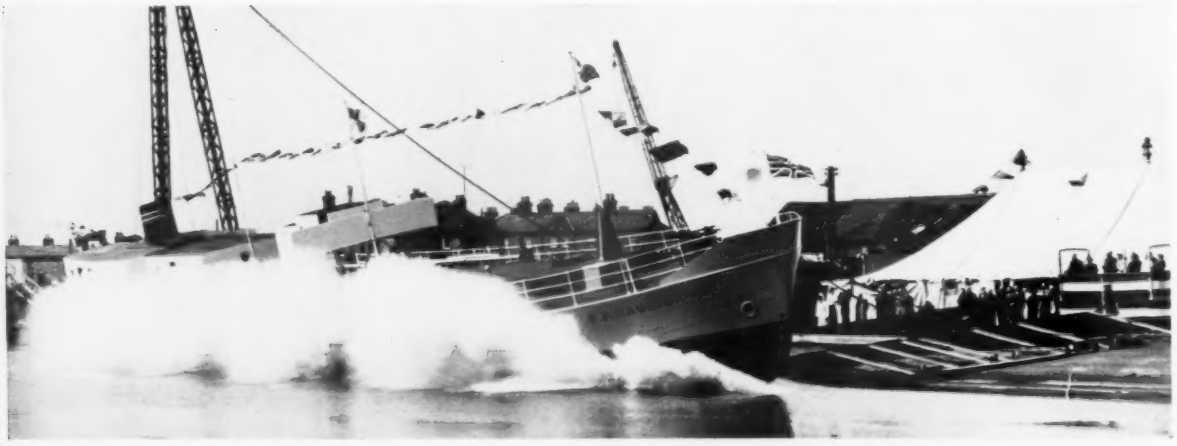
Tanks Nos. 2 *and* 3. These two cargo tanks, which will normally also be used for water ballasting, are protected by the "Guardion" system of cathodic protection developed by the Marine Research and Development Department of the Anglo-Saxon Petroleum Co. in collaboration with F. A. Hughes and Co. Ltd., who undertook the installation. The method has proved effective in ocean-going vessels of the Shell tanker fleet, but could not be used in the non-ballast tanks (Nos. 1 and 4) of this vessel.

Tank No. 4. The interior of this tank is metal spray coated. After gritblasting with angular chilled iron grit, the surface was sprayed with aluminium to a thickness of 0·005-inch minimum by the wire process, 50-sq. ft. sections being treated at one time to avoid deterioration of the prepared surface before metal application. The work was undertaken by Metallisation Ltd.

Engines and Machinery

Built by Clelands (Successors) Ltd. at Wallsend-on-Tyne to Lloyds —100 A.1, the dimensions of *Shell Welder* are: Length B.P.—160 ft; Breadth moulded—29 ft; Depth moulded —11 ft 3 in; Draft, maximum—10 ft 5 in.

Main propelling machinery is a Crossley HRN 6/40 diesel of 570 b.h.p. for a service speed of $9\frac{3}{4}$ knots loaded. Auxiliaries are three Crossley BW.6, 90-b.h.p. diesels for compressor, generator, and general service pump, etc., and a hand-starting Crossley BW.1 diesel coupled to a bilge and ballast pump and a compressor.



B.P. Haulier *is launched, across stream, on the river at Faversham.*

★ ★ ★

"Oil"

"There may still be ignorant persons to whom the idea of a large oil company conjures up a big and stony-hearted monopolist raking in the shekels and riding roughshod over the persons and personalities who have granted the concession," declared Colonel J. W. Chitty, M.B.E., F.C.I.S., assistant secretary of the Iraq Petroleum Company Ltd., in a paper on "Oil" read at the annual conference of the Chartered Institute of Secretaries at Folkestone.

"A glance at the changing face of the Middle East should dispel this," said Colonel Chitty. "Persia has recently been so much before the public as to need no comment; in Kuwait a small section of desert is now a hive of enlightened industry and progress. In Iraq the economic foundations are being laid on which a country of some five million inhabitants may justifiably hope to rebuild the prosperity of a thousand years and more ago, support twenty millions in comfort and provide a new granary for a food-hungry world.

"Apart from the technical ramifications of the oil industry, the incidental activities are worthy of consideration. In the production and operational centres of the Middle East, oil companies have to provide and arrange facilities for practically all the necessaries, as well as amenities, of the day-to-day life of their employees.

"In 1920, Kirkuk was a town of some 30,000 inhabitants, with no water, light or sanitation. By 1950 the population had risen to 75,000 and Kirkuk is now a thriving municipality on its own account, while in 25 square miles of what was neighbouring desert is an entirely new collection of offices, bungalows, technical plant, workshops, tanks and pumping equipment to start the source of all this new civilization on its way to market."

Some Notes on the Uses of Emission Spectrography in the Petroleum Industry

By J. NOAR*

PART I. The Emission Spectrographic Method

Introduction

As the title implies, it is not intended to present a comprehensive article, but rather to discuss selected aspects of emission spectrography which are considered to illustrate best the potentialities and limitations of this analytical tool with respect to petroleum problems.

It is unnecessary to stress how analysis in industry is increasing in importance and expense; nowadays this importance is accepted, albeit sometimes with reluctance, as a logical consequence of the increasing complexity of industrial processes, the increasing exactitude with which raw materials, processes, and products are controlled, and the increasing volume and scope of industrial research. It is perhaps as well, however, to indicate briefly why the essentially inorganic data provided by the emission spectrograph are needed in an industry primarily concerned with organic materials. The simple answer is that petroleum components and products, throughout their complex and devious histories, are in intimate contact with inorganic or metal-containing substances. Such metal-containing substances are, for example, geological neighbours of the crude petroleum, they are also present in pipelines, storage or transport tanks, the refinery materials, catalysts, additives, and the components of the various engines, machines, boilers, etc. in which the products are used. This association frequently leads to mutual influences which can be classified under such headings as corrosion, abrasion, catalysis and the poisoning of catalysts, ash deposition, additive depletion, contamination, and so on. It is not hard to visualize the part played by inorganic analysis with respect to these features, and how they contribute increasingly to the analytical load. It should be appreciated that this load increases not only in the numbers of submitted samples, but also in scope; where previously the interest was in small traces, it is now in smaller traces; samples may also be smaller, greater accuracy may be needed, more elements sought, and nearly always quicker reporting of results is required. Consequently it is not always sufficient to increase analytical facilities proportionately with sample numbers, and refinements to streamline the older chemical methods only partly meet the deficiency, sometimes even at the risk of being less reliable than previously. It is little wonder then that much interest is now centred on instrumental methods, which in general are more suitable for mass producing data. One method, that of emission spectrography, has achieved notable successes in this direction in a number of fields, and appears set to achieve similar successes in the petroleum industry. Let it be admitted immediately that such successes are not entirely unqualified, and some adverse comments of Professor van Nieuwenburg[1] are quoted below from his lecture on "A contemporary assessment of the place of classical methods in chemical analysis":

" . . . Spectrography has unmistakable drawbacks. The apparatus, if really efficient, is expensive, so that its application will always be restricted to relatively large laboratories. And what is even worse, it can only be efficiently used in fairly well-equipped laboratories with good mechanical and electrical services. Generally speaking, I think we may aver at least that now and in the near future, emission spectrographic analysis is limited to inorganic routine work in large laboratories with a specialized and highly skilled staff. But there is more; even when carried out in expert laboratories, it cannot as yet always attain the same degree of certainty and precision as chemical analysis in the more limited sense of the word. It is not as if a given amount of an element, even in the same apparatus, always gives the same intensity of spectrum line, independently of the state in which it is present. Sometimes it does, but there are a great many unforeseen exceptions. . . . Emission spectrography still needs fully reliable samples of known composition, analysed by classical means, and zealously internationally collected and guarded. As yet it cannot even stand exclusively on its own legs. . . . Now I fully realize that this will improve day by day."

Later in this article the writer will try to dispose of some of Professor van Nieuwenburg's misgivings, but nevertheless there is a great deal which as yet cannot be ignored in a fair assessment.

The Emission Spectrographic Method

Basic Features

Each element is capable of emitting radiations which are specific for each atomic state of that element. The emission spectrograph provides a means of dispersing and recording these radiations as atomic spectra.

This specificity of atomic spectra provides the basis for qualitative analysis. Components of a complex mixture can be readily identified from its spectrum. The main practical limitation is that some elements are either not easily excited or their main spectral lines are not in the most accessible wavelength region. Fortunately, all the metallic elements and some metalloids are included in the 70 or so elements which are amenable to the simpler techniques and apparatus.

The excitation-radiation cycle of any atom can be repeated any number of times, but with current sources only a small proportion of the atoms introduced are excited.

It can therefore be appreciated that the present good sensitivity is still capable of enormous improvement (see section on sensitivity).

The intensity of a line in a characteristic spectrum depends upon a number of features, one of which is the concentration of the appropriate atoms in the source.

The dependence of intensity upon concentration provides the basis for quantitative analysis. However, it is necessary, but by no means easy, to ensure that the concentration of radiating atoms in the source is unambiguously related to the concentration of the parent element in the sample. Furthermore, the intensity of a spectral line can be markedly influenced by source conditions (size of source, its temperature, etc.) and also by processes involving the absorption or scattering of radiation.

It would seem then, from a consideration of these few features, that the spectrographic method is readily suited to qualitative analyses in that it is both specific and sensitive, but for quantitative analysis the position is much more complicated; certainly a number of variables need to be

*Thornton Research Centre.

controlled or accounted for before the intensity of a spectral line is assumed to be a reliable indication of concentration.

General Scheme of the Quantitative Method

Most emission spectrographic methods follow the scheme shown in Fig 1.

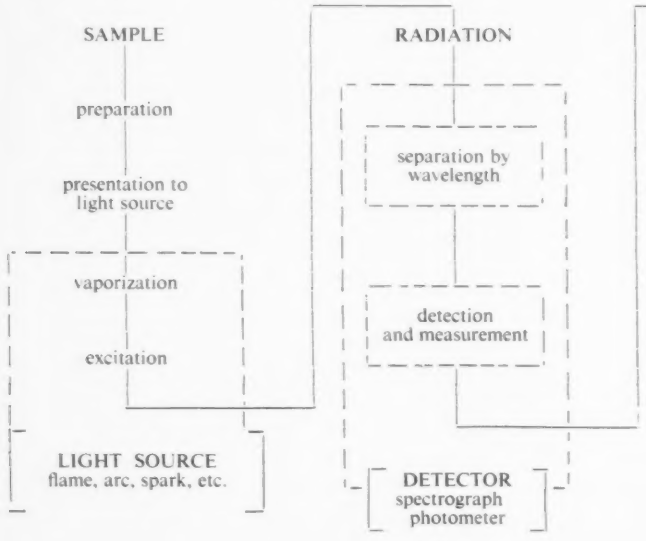


Fig 1.

Sampling follows the strict requirements common to all micro methods, and need not be considered further here.

Sample preparation serves for a number of purposes; as a means of concentration, to remove interfering constituents, to bring all samples (and standards) to a common form, or for the addition of internal standards and radiation buffers. Internal standards are "controls" which enable corrections to be made for variations in excitation and detection, while the purpose of radiation buffers is to reduce variations in excitation. Sample preparation can be very important, but for those spectrographic methods which are utilized for their economy in handling large numbers of samples, the rule is to keep this preparation stage as short and as simple as is compatible with the degree of reliability required in the resulting analyses. One other point about sample preparation is that each stage of manipulation is not only time-consuming, but also involves an extra risk of contamination—a feature of some importance in micro-work.

Excitation and the generally associated vaporization and dissociation are produced by flames and electrical discharges and, occasionally, by some other means such as a furnace.

The cooler flames (coal gas–air) excite only a few elements, namely, the alkali metals and alkaline earth metals, while the hotter flames (acetylene–oxygen or acetylene–air) excite 30–40 elements. A sample can be introduced into a flame by mechanically feeding a solid[2] or, as is more usual, by spraying a solution of the sample[3]. Sensitivity is good by both means, and this is particularly important for elements such as sodium and potassium, which are often difficult to estimate as traces by non-spectrographic methods. By the selection of suitable conditions, flames burning sprayed solutions can be made very stable over a considerable period of time, and are highly reproducible. Consequently this method of excitation lends itself to very reproducible analyses. Unfortunately, the intensities of flame spectra are often influenced by sample constituents other than the analytical elements, and this detracts from the reliability or simplicity of the method when diverse sample types are to be examined.

Electrical discharges which are used as excitation sources include continuous direct current arcs, intermittent alternating current sparks and high frequency discharges. Variations of these systems now cover a very wide range, and it is possible to select sets of discharge conditions each suited to the physical condition of the sample and to various analytical requirements such as sensitivity, reproducibility, virtual non-destruction of the sample, and so on. Sometimes, however, the analytical requirements may be antagonistic; for example, extreme sensitivity is not usually compatible with non-destruction of the sample, nor with the highest accuracy. In these cases it is necessary to employ some intermediate source conditions—the finer details of which are usually selected by trial. With electrical discharges there are also many ways in which the sample can be introduced. For metallic samples, either one or both of the electrodes can be formed by the samples themselves. For powders, the lower of two vertically-aligned electrodes can be shaped to contain the powder, and a variety of shapes has been used for many purposes including traces in soils[4], major constituents of rocks[5], a wide-range semi-quantitative method[6], and volatile traces in a refractory matrix[7]. Shaped electrodes can also be used for metals examined either as powders[8] or by the globule method[9]. Other ways of examining powder samples are to compound them into pellets[10, 11] or to fuse the samples and then dip electrodes into the fused mass[12]. Liquid samples can either be dried or adsorbed on to semi-porous[13] or non-porous[14] electrodes, or introduced through the porous base of an upper cup-shaped electrode[15]. Another device for dealing with solutions is the rotating disk[16, 17] which dips into the solution, carrying it continuously into the discharge. The rotating disk can also be used for powders, in which case the powder is incorporated into the mixture from which the disk is pressed[18, 19].

Radiation from the light source is examined by means of a spectrograph or spectrophotometer. The dispersing element needed to separate the various wavelengths depends upon the complexity of the spectra to be examined. For the cooler flames, or for all flames where only one or two elements are excited, optical filters may suffice. For radiation from electrical discharges, a prism or grating system is necessary and its dispersion must be increased in accordance with the complexity of the spectra. The system of greatest dispersion can be applied to all kinds of spectra, but such a system is generally least efficient in the use of the radiation, *i.e.*, luminosity is decreased, and the wavelength range may be reduced, particularly with photographic instruments.

Detection. The radiation-sensitive detector may be the eye, a photographic emulsion, or some photo-electric device (photocell or Geiger-counter).

The photographic emulsion is the detector most commonly used with prism and grating systems, and is particularly useful for qualitative work, for providing a permanent record, and for its effective sensitivity. It is also satisfactory for most

quantitative work, although in this case the evaluation of the photometric data is rarely simple and can in some cases be time-consuming.

Photo-electric detectors are not as yet so commonly used as photography, but there is little doubt that this situation is altering rapidly. Photo-electric measurements can be made much more quickly and the results calculated more easily than those from photographic measurements and, with the best electron multiplier photocell arrangements, sensitivity is about the same as by photography, while precision is much better. Photo-electric methods are not so good for qualitative work however, and for some quantitative analyses make more demands upon the source (*e.g.*, require that background is low or constant, or that the spectral line intensities do not vary greatly with time).

Evaluation of the photometric data in terms of concentration depends upon the type of detector used and the type of analysis carried out. The calibration between concentration and line intensity ratio is based upon standard samples, in which the concentrations of the relevant elements are sufficiently well-known, either from the synthesis of the standards, or by the application of alternative analytical methods. Calculations are usually based upon the relative intensities of analytical element and internal standard lines[23], this serving to minimize variations in both the intensity of the light source and the sensitivity of the detector. The internal standard may be a normal constituent of the sample (if possible, a major constituent of invariable concentration) or it may be intentionally added to all samples and standards.

Sensitivity

Sensitivity is expressed in terms of the smallest amounts or concentrations which can be detected or measured. The sensitivities of well-known methods are as follows:—

(1) **The D.C. carbon arc, cathode layer method**[4]

Element	*Sensitivity p.p.m. (on 4 mg sample)*
Ag, Cu, Cr, Ga, Li, Mo, Ni, Ba, Mg	1–5
Sr, Pb, Sc, Ti, Sn, Be, V, Ge, Mn, Al	5–20
La, Rb, Tl, Y, Zr, Si	20–50
Bi, Cd, Cs, Sb	50–500
As, Hg, W, Zn	500–2000

plus other elements to a total of about 70 of various sensitivities throughout the above range (1–2000).

(2) **The A.C. graphite arc**[20, 21, 22]

Element	*Sensitivity p.p.m. (on 12 mg sample)*
Al, Ca, Mg, Cu, Cr, Fe, Mn, Ni, Pb, Sr, Sn	<1–5
Zn, Si	5–25

(3) **The carrier distillation method for impurities in refractory matrix**[7, 22]

Element	*Sensitivity p.p.m. (on 100 mg sample)*
Ag, Au, B, Be, Bi, Cu, Ge, In, Mg	<0·1–0·5
Al, As, Co, Cr, Fe, Mn, Mo, Ni, Pb, Si, Sn, Tl, V	0·5–5
P, Sb, Zn	5–50
Na (3302·3)	150

(4) **The porous cup method**[15]

Element	*Sensitivity p.p.m. (on 0·2–0·3 ml solution)*
Be, Mg	0·01–0·1
Ag, Al, B, Li	0·1–1
Bi, Cb, Co, Cr, Cu, Fe, Ga, Ge, Hf, In, La, Mn, Ni, Pb, Re, Ti, V, Zr	1–10
As, Au, Cb, Ce, Cs, Hg, P, Pt, Ru, Sb, Sn, Th, Zn	10–100
Te, W	100–1000

(5) **A flame method**[24] **for solid samples**

Element	*Sensitivity p.p.m. (on 15 mg sample)*
Cu, Mn Rb Fe .L	0·1–1

(6) **A flame method**[25] **for liquids**

Element	*Sensitivity p.p.m. (on 2 ml solution)*
Ca, Co, Cr, Cu, Li, Mn, Na, Sr, Tl	0·1–1
Ag, Fe, K, Mg, Ni, Rb, Ru	1–10
Au, Ba, Cs, Pb, Pd	10–100
Cd, Hg	200
Zn	3000

(7) **A flame method** (for liquids) based on the older type Beckman Flame Photometer[26]. (**N.B.** use of the newer burner and electron multiplier photocell should considerably reduce the lower limits given here.)

Element	*Sensitivity p.p.m. (on 1 ml solution)*
Cs, Li, K, Rb, Na	0·01–0·1
Ca*, Cu, Ga, In, Mn, Sr, Tl	0·1–1
Ba*, B*, Cr, Co, Fe, Mg, Ni, Ag	1–10
Au, Hg, Pd, Ru	10–100
Pb	300
Cd, Sn	500
Se*	5000

*by oxide bands.

(8) **A globule arc method for copper**[9]

Element	*Sensitivity p.p.m. (on 50 mg sample)*
Bi, Pb, Ni, Sn	2–5
As, Ag, Sb, Fe	10–20

It can be seen from the above and other methods[14, 27] that sensitivity is generally very good. For some 70 or so elements it is generally possible to detect amounts of less than 10^{-6} g and often less than 10^{-9} g. These low (absolute) limits are also of very great value where concentration processes are necessary, as this permits a reduction in the degree of concentration or, alternatively, in the initial amount of sample. Chemical concentration processes prior to spectrographic examination have received much attention in some fields[4, 22, 28, 29, 30] and seem likely to be applied more widely in future. One limiting factor of spectrographic sensitivity is the smallness of the amount of material which can actually be sampled in the source. Thus an absolute sensitivity of 10^{-6} g would only correspond to a lower (concentration) limit of 0·01 per cent if not more than 10 mg could be handled. Similarly, it might be necessary to consider the sensitivity of a solution technique not as concentration in the solution, but as concentration in terms of amount of solid sample dissolved in the solution. For example, if 0·1 per cent solutions of the samples were used for the porous cup method (given above) then the sensitivity limits shown with respect to concentration in the solution must be multiplied a thousandfold. Despite these matters, and also occasional disturbances due to line interferences etc., it is still clear that emission spectrographic methods have very real advantages over other methods for the majority of the elements.

It is now necessary to consider the minority of elements not represented by the above examples. The most important of these elements are sulphur, selenium, and the halogens. The difficulty with these elements is that they are not easily excited in the presence of elements with a lower ionization potential, and that their main lines lie at somewhat shorter wavelengths than those normally used. It has been shown to be quite practical to determine these elements, however. For example, a vacuum spectrograph and suitable excitation conditions permit routine analysis of steels for sulphur[31] down to 0·002 per cent. Even in the more accessible wavelength region some successes have been achieved by the use of molecular spectra[26, 28, 32] or by using a high frequency discharge[33, 34] giving sensitivities in the 10 p.p.m. range. Considerable success with these difficult elements (S, halogens) has also been achieved by the hollow cathode source[35], quoted sensitivities being: fluorine 1 p.p.m. in 100 mg sample; chlorine, 50 p.p.m. in 20 mg; sulphur, 10 p.p.m. in 20 mg. It is of great practical importance that the difficulties of manipulating the hollow cathode source appear to have been very much reduced by newer designs[36]. Another apparently

satisfactory method for halogens[37] is based on normal spark excitation in an inert atmosphere, *e.g.* CO_2 or He. This appears to be a very simple technique with a sensitivity (0·1 per cent) quite acceptable for some purposes, and has been applied to engine deposits[38, 39]. In the first of these applications[38] 1–2 mg samples were analysed quantitatively down to 1 per cent for Cl, Br, S; Pb was also determined from the same spectrogram. A rotating copper disk method[40] has also been used for the quantitative determination of sulphur in solution down to 0·002 per cent, the same paper describes the determination of carbon in cast iron and steels.

The Time Factor

The time factor in analysis is important in two ways, namely, throughput per operator (or average time per determination), and the elapsed time between receiving a sample and reporting the results. Because of the high cost of laboratory space and skilled labour, throughput is nearly always important, whereas the value of speedy reporting might be of lesser or greater importance. Spectrographic methods can be particularly good in both of these ways. The most impressive achievements are those of direct reading spectrographs which can analyse certain metal samples at the rate of one every 2–3 minutes for up to 13 elements. Flame photometers are also capable of rates of one sample every few minutes, but for spectrographic methods employing photographic detection and as generally used at present for petroleum analyses, the throughput is about 10–20 samples per operator-day. As this would involve an average of 50–100 determinations it is many times greater than can be achieved by chemical methods.

So far as concerns speed of reporting, for single samples current spectrographic methods might take up to four hours depending upon the amount of sample treatment. It is possible to modify some methods to give results more quickly. Thus, the elapsed time might be about 30 minutes for lubricating oils (clarified[41] or otherwise[42]) and, in some cases where speed is of extra importance, as for example when checking road diesels for oil changes, this time can be reduced[43]. Likewise, analysis time for catalytic cracking feedstock has been reduced from more than 1 day (chemically) to 1 hour (spectrographically)[44]. Similar savings are reported for residual fuels[27], cracking catalyst,[45] metals' identification, and so on. It should be noted that the increase in speed is not accompanied by any lowering in accuracy. In fact, spectrographic methods of the type referred to are often more reliable than chemical methods, in that they are less liable to errors arising from contamination or losses during ashing.

So far as time is concerned, however, there is one feature which might partly offset some of the advantages of the spectrographic methods. Spectrographic methods sometimes require appreciable time spent initially on development and calibration and although, as will be mentioned later, this time is not necessarily lost, it is a factor to be considered against the likely gains of the subsequent application.

Accuracy

While there can be little doubt about the satisfactory analytical speed and sensitivity which can be attained by spectrographic methods, it is often supposed that accuracy is much worse than with chemical methods except for trace concentrations which are barely accessible to these chemical methods. This point of view, once largely justified, is now rapidly losing ground as spectrography is becoming better understood and more soundly applied. Before proceeding further into this matter it is as well to appreciate the distinction between accuracy and precision. Accuracy concerns the closeness of measurements to the correct figure, whereas precision concerns the closeness of replicate measurements to each other. In analytical work the correct figure is never known exactly, and is replaced by a "best" figure, which is one derived by the method or methods which are considered to be the most reliable. For example, the best figure for a mixture synthesized from pure chemicals might be the calculated figure, whereas the best figure for a component in an unknown sample would be derived from replicate determinations by a method, or methods, which is considered (from theory or practice) to be virtually free from systematic errors for the particular sample being examined. Often the analytical method considered to be the best is a chemical one, but this is not always so, even where major constituents are concerned. Gillis and Eeckhout have summarized some relevant investigations[46, 47].

The point to be made here is that although precision can be measured by simple objective methods, an estimate of accuracy usually requires a more detailed knowledge of the samples and methods involved. Precision and accuracy are the same thing only when systematic errors can be discounted. However, physical or instrumental methods of analysis are nearly always liable to systematic errors (indeed many chemical methods are similarly affected owing to slight solubilities of precipitates, adsorption on precipitates, losses on ignition, and so on).

The precision of spectrographic methods can be considered briefly as follows:—The uncertainty owing to source irregularities is generally ± 1–5 per cent (expressed as a coefficient of variation) and the uncertainty of measurement is about ± 1–5 per cent with photographic recording[48], less than ± 2 per cent with a barrier layer photocell, and less than ± 1 per cent with an electron multiplier photocell. If errors due to sampling and pre-treatment can be ignored, then it follows that the overall precision of a spectrographic method should lie between 1·5 and 7 per cent and possibly, below this range where photo-electric measuring is employed. These figures apply to individual exposures and measurements, and of course can be reduced by replication. This order of precision is quite acceptable for much analytical work—if systematic errors can be kept small or corrected for. In some cases this control of systematic errors is made relatively easy because samples are closely similar in chemical composition and physical form, and suitable standards of known composition are available. In cases where chemical composition differs from sample to sample, the effect of this can often be reduced by dilution into a standard matrix, by the incorporation of a radiation buffer, by choosing the excitation conditions which are least sensitive to the differences encountered, or by adding materials (internal standards) which will give a measure of the influence of these differences so that corrections can be readily applied. The effects of differences in physical form can also be reduced by similar means or, more directly, by bringing all standards and samples to a common form by solution, fusion, ashing, chemical reaction, and so on. Obviously, the effectiveness of the applied controls decides the magnitude of the possible systematic errors, and hence the overall accuracy of the method. As has been already stated, some sample types are amenable to control and the accuracy with which they can be analysed is about the same as the analytical precision. In other cases systematic errors might cause discrepancies between spectrographic and true figures of an order of two.

Summarizing the discussion in this section, it can be said that present-day spectrographic methods can give satisfactory accuracy in certain cases, particularly where samples are of standard types or can be converted to standard types, but may give only semi-quantitative accuracy in other cases, particularly where samples are diverse and controls cannot be conveniently applied.

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HD Oils

The following additional oils have been approved by the Director of Chemical Inspection, Ministry of Supply, as complying with the requirements of Defence Specification DEF 2101A.

Supplier and Supplier's Nomenclature	*OMD Grade of Oil*
Deutsche Shell A.G.	
Shell Oil S.3642	330
Shell Oil S.3507	60
Shell Oil S.4270	40
Shell Oil S.4272	330
Gewerkscheft Neue Erdol Raffinerie	
Nerag Motor Oil 500 HD SAE 30	110
Nerag Motor Oil 800 HD SAE 10W	40
Nerag Motor Oil 810 HD SAE 20/20W	60
Shell Petroleum Co. Ltd.	
Shell Oil S.4454	330
Deutsche Vacuum Oel A.G.	
Servac 520	60
A.B. Nynas Petroleum	
Ajcol HD SAE 30	110
Engelbert & Co. (Lubricating Oils) Limited	
Lubol DEF30 HD	110
Lubol DEF 20W/20HD	60
Falcon Oil Co. Ltd.	
Luxol OMD 60	60
Luxol OMD 110	110
Luxol OMD 330	330
Esso A.G.	
Veloxol (P) HD 10W	40
Super Purol HD4 SAE 10W	40
Veloxol (F) HD 20/20W	60
Super Favorit HD6 SAE 20/20W	60
Veloxol (P) HD 20/20W	60
Super Purol HD6 SAE 20/20W	60
Veloxol (F) HD 30	110
Super Favorit HD8 SAE 30	110
Super Purol HD15 SAE 50	330
Veloxol (P) HD50	330
Super Purol HD8 SAE 30	110
Veloxol (P) HD30	110
Liberty Oils Ltd.	
Onegal DM30	110
Vacuum Oil Co. Ltd.	
4309/76	60
C. C. Wakefield & Co. Ltd.	
Wakefield HL/121/54	40
W. Walker & Sons (Hanley) Ltd.	
Centos XHD30	110
Rudolph Fuchs Mineraloelwerke	
Penna Pura Super 10W	40
Caltex Oil (Australia) Pty. Ltd.	
Caltex 2290	330
Esso Petroleum Co. Ltd.	
Esstic HD 30	110

Law and Management for the Chemical Engineer

Discussion of Modern Industrial Problems

A symposium under the above title was held by the Graduates' and Students' section of the Institution of Chemical Engineers at the University, Birmingham, on 15 April 1955.

Four papers were presented, these being "Law in relation to the chemical engineer" (V. Biske); "Negotiations between organized labour and management in relation to the chemical engineer" (G. Brearley); "Safety and welfare" (A. Webster); "Personnel management and human relations" (A. S. Roy).

Law

After outlining the modern system of delegated legislation, and reasons therefor, the first speaker gave a short account of the legal status of the chemical engineer and of some of the essential features of the law of master and servant.

The legal consequences which could arise from strikes were briefly considered, with reference to the penal provisions of the Conspiracy and Protection of Property Act, 1875, relating to breach of contracts of employment in certain industries, and to the simplified procedure provided by the Employers and Workmen Act, 1875, for recovery of damages from workmen.

The legal aspect of pollution problems was mentioned and the difference between statutory and Common Law remedies explained, the former being a public remedy involving the criminal courts and the latter a private action in a civil court for damages and or an injunction.

The scope of the Factories Acts was outlined and the suggestion made that, as manual labour entered into the definition of a factory, the position of the automatic factory, a possibility of the not too distant future, might be of considerable legal interest.

The speaker concluded with an indication of how to find the law on any particular topic, particular reference being made to official Government publications and the facilities afforded by H.M. Stationery Office.

Labour Relations

In the second paper of the morning session the history of organized labour in the United Kingdom from the early beginnings to the present position of about 200 unions comprising 8 million members and united through the medium of the Trade Unions Congress, was outlined and the chain of contact between the individual worker and the T.U.C. explained. The speaker said that on the employers' side the counterpart of the T.U.C. was the British Employers Confederation, comprising 60 employers' organizations. Increasing Government concern with industrial matters had led to the formation of Regional Boards for Industry, comprising representatives from employers, trade unions, and Government departments, which were mainly concerned with matters affecting productivity.

Questions of general policy on the national level, such as legislation affecting all industry, were, from the employers' standpoint, dealt with by the Federation of British Industries; there were various subsidiary bodies concerned with specific industries and for the chemical industry the counterpart of the F.B.I. was the Association of British Chemical Manufacturers, which was concerned with matters such as safety and legislation, but which excluded any dealings with wages and prices. Within this Association there were various specialized groups such as that, for instance, concerned with dyestuffs.

In the field of management–labour relations within the chemical industry, the employers were represented by the Association of Chemical and Allied Employers which, together with the unions concerned, formed in 1920 a Joint Industrial Council, an important step in ensuring good industrial relations. Owing to its preponderant position in the chemical industry of the United Kingdom, Imperial Chemical Industries was not a full member of this Association, and carried out its own direct negotiations with the unions involved.

In addition to dealing with wage negotiations, the Joint Industrial Council also had the function of organizing training schemes for the up-grading of employees and of taking steps for the improvement of productivity.

The speaker then described how, apart from such national organizations, co-operation was also ensured at the international level by the International Labour Organization, which was a specialized agency of the United Nations and had a tripartite structure composed of representatives from Government, management, and labour. The chemical industry committee of the I.L.O. was founded in 1947 and had passed resolutions concerning matters such as hours of work, labelling of dangerous substances, and industrial relations, particularly, in the case of the last, with regard to under-developed countries.

Such resolutions formed what were known as Geneva conventions, which formed the pattern for future legislation of the countries, such as the United Kingdom, participating in the conventions. The normal United Kingdom representation at meetings of the I.L.O. chemical industries committee comprised six, of whom the Government appointed two, the Association of Chemical and Allied Employers and I.C.I. one each, and the remaining two were appointed by the unions mainly concerned (Transport and General Workers, National Union of General and Municipal Workers, and Union of Shop, Distribution and Allied Workers). In addition advisers on special topics might also be included.

The various union mechanisms mentioned applied, however, only to hourly paid staff. For more senior personnel it was somewhat difficult to create appropriate union machinery, although some moves in this direction had been made in the chemical industry by the British Association of Chemists and by the Association of Scientific Workers.

Safety and Welfare

In the first of the afternoon papers particular attention was paid to the provisos concerning safety and welfare matters which are to be found in the Factories Acts and in the Chemical Works Regulations. The importance of ensuring safe means of access to work was especially important, the speaker said, and he emphasized the advisability of consultation with insurance companies in regard to certain problems,

such as those concerning pressure vessels. The value of adequate liaison between safety and medical departments in a chemical works was stressed, as even non-notifiable minor injuries could cause a very considerable amount of lost time. The normal method of expressing such lost time was in terms of days per 100,000 man hours, the latter figure representing roughly the average individual's working life. A frequency figure of 0·5 due to lost-time and reportable accidents could be considered as reasonably satisfactory.

Many instances of injury occurred, the speaker said, owing to the performance of ancillary operations, for example, bottle washing, without adequate instruction, and in many cases the safety aspects of such minor, but essential, procedures were not given adequate weight.

Other points touched upon by this speaker included the organization of fire fighting and the toxic dangers that could arise from new products, introduced commercially before their hazardous properties were properly understood.

Welfare activities, although important, could be overdone and there was a certain danger in a paternalistic attitude to such amenities.

Personnel Management

The last paper of the day dealt with what is a modern topic of recent importance. Speaking of the incentive to work the lecturer said that this was not purely financial but included factors of economic, individual, and social satisfaction. A personnel management department should consider education and training as one of its main aspects, not forgetting the more difficult question of training supervisors and the importance of giving information to new employees on the functions of the organization they had joined, and of their place therein. The importance of the identification of a supervisor with his group as a means of raising productivity was pointed out.

In the speaker's opinion the present wage structure in the United Kingdom was somewhat chaotic and there was much to be said for a method of merit rating allied to job evaluation, so that an individual's ability could be more accurately assessed than at present; such a system would also enable additional wages to be granted to the more efficient person.

Despite the elaborate trade union machinery which had been set up, there was still room for *ad hoc* consultation on the shop floor, which could do much to avoid more formal and time-consuming negotiations.

The speaker finally dealt with the problem of executive development and the advisability of moving some of the more likely candidates out of specialized departments, such movement being a horizontal displacement and not necessarily a promotion, so as to enable them to gain more experience and to prove their latent ability to assume wider responsibilities. Such a course had, however, the possible danger of having an adverse effect on those executives not selected for such a move, and from this aspect, tactful handling was essential.

Each of the papers was followed by about half-an-hour's discussion, in which many of the points made by the speakers were elaborated more fully and which also enabled members of the audience to express their own views.

General chairmanship of the meeting was undertaken by P. M. Shaw; the morning session was chaired by B. Edgington (chairman of the Midlands branch of the Institution) and the afternoon session by J. G. Picton (sub-dean of the Faculty of Commerce and Social Science, University of Birmingham).

V.B.

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Notes of the Month

Iranian Oil

During March this year 1,218,000 tons of crude oil were produced in South Iran by Iraanse Aardolie Exploratie en Productie Maatschappij (Iranian Oil Exploration and Producing Co.) N.V. Total production for the year to the end of March was 3,120,000 tons. Iraanse Aardolie Raffinage Maatschappij (Iranian Oil Refining Co.) N.V. had a throughput for March of 637,000 tons, contributing to a total of 1,865,000 tons for the first three months of 1955.

Socony-Vacuum Change of Name

The name of the Socony-Vacuum Oil Company was changed recently to Socony Mobil Oil Company, Incorporated.

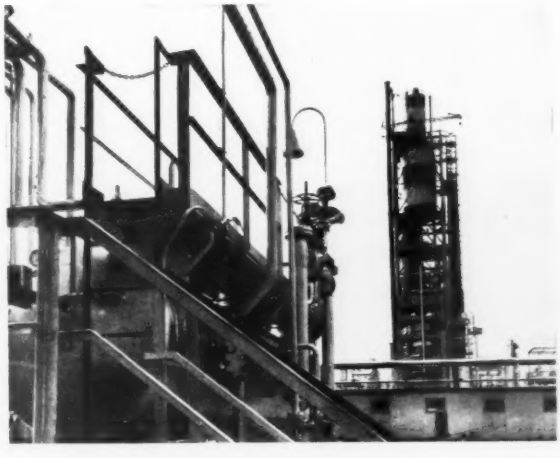
New Australian Refinery

Australia's first refinery to produce gasoline by the catalytic cracking process was opened officially during April by the Prime Minister of Australia, Robert G. Menzies.

The refinery is situated at Altona, 12 miles from Melbourne, and is operated by the Australian refining subsidiary of the Standard-Vacuum Oil Co. Ltd. The 25,000-b.d. plant, which came into operation some time before the official opening, is scheduled to meet more than 16 per cent of Australia's demand for petroleum products and 20 per cent of her gasoline requirements. Australia is sixth in the world in *per capita* consumption of oil products—210 gallons—and demand is expected to increase. The refinery's output is expected to save Australia over 82 million a year in foreign exchange.

Altona has been the site of a 2000-b.d. lubricating oil and asphalt refinery since 1949. Now, in addition to the catalytically-processed high-octane gasoline, the refinery will produce kerosine, aviation turbine fuel, diesel oils, lubricants, fuel oils, and asphalt. High-grade aviation gasolines will be added to this list in 1956 when an alkylation plant processing 1600 barrels a day will come into operation.

Altona is the third major post-war refinery to be built for Standard-Vacuum in the Eastern Hemisphere. The other two came into operation at Durban and Bombay during 1954.



The 25,000-b.d. plant with its 286-ft Thermofor catalytic cracking unit. In the foreground is part of the solutizer treating plant.

History Commemorated

An interesting ceremony was performed at the Brentford works of Varley Pumps and Engineering Ltd. on 29 April. While removing an old slag heap, a stone first erected in 1909 and commemorating local events from the opposition to Caesar by the tribesmen under Cassivelaunus in 54 B.C. to the Battle of Brentford in 1642, was discovered. The stone has been re-erected by the Company on a permanent site, a 999-year lease of which was given to the local Council by J. H. Bentley, the managing director, and received by the Mayor. Among those present at the ceremony was Julius Caesar, A.F.Inst.Pet., who incidentally is on the engineering staff of the Vacuum Oil Co. Ltd.

After being entertained to lunch, the guests were conducted around the works to witness the manufacture of the Company's products, which include such items as internal gear pumps for gasoline dispensing, vane pumps for forced lubrication, testing units for diesel injectors, etc.

Change in Iranian Refining Co. Directorate

D. L. Hussey has resigned from the Board of Directors of Iraanse Aardolie Raffinage Maatschappij (Iranian Oil Refining Co.) N.V., and P.E. Kuhl has been appointed to fill the resultant vacancy on the Board.

British Oil Burner Manufacturers

Some 200 members of the British Oil Burner Manufacturers Association Ltd. and their guests were present at the annual general meeting of the Association during May. The occasion marked the 21st anniversary of the Association and the meeting was followed by a luncheon at which the principal guest was the Hon. L. W. Joynson Hicks, M.P., Parliamentary Secretary to the Ministry of Fuel and Power.

Officers of the Association who have been re-elected for a second year are President: J. R. C. Boyce, British Oil Burners Ltd.; Vice Presidents: J. D. Fitzgerald, Combustions Ltd., and F. C. Pillinger, G. C. Pillinger and Co. Ltd.; Honorary Secretary: R. H. G. Sutton, Urquhart's (1926) Ltd.

RPS Exhibition of Applied Photography

No exhibition of applied photography would be complete without some examples from the petroleum industry, and the recent Spring Exhibition of Applied Photography held by The Royal Photographic Society in London, 4–27 May, was no exception to this rule. In this connexion the "Shell" team was represented by C. D. V. Knight and E. Willmott with plant pictures and by C. Cadwallader with an example of insecticide photography. Four Agfacolor prints by H. R. Barker of Thornton Research Centre Photographic Department illustrated the value of colour in the examination of bearings for corrosion.

Models and dioramas showing different aspects of the Kuwait Oil Company's operations have been prepared for display at the Company's new information centre at Kuwait.

The model shown here is of the oil port at Mina al-Ahmadi. It has been made to the scale of 200 ft to 1 inch.

Other oil pictures were one of oil tanks by A. Sternberg of Manchester and one of drill collars by V. Oliver of English Steel Corporation Ltd.

This exhibition is the first of a new series organized by the RPS. In future, instead of an annual comprehensive exhibition, there will be three each year. The Spring show will be devoted to practical application and two in the Autumn will cover respectively pictorial and nature photography.

Italy's First Platformer

Work is progressing on the construction of Italy's first platformer at Porto Marghera refinery, Venice, jointly owned by The British Petroleum Co. Ltd. and Azienda Generale Italiana Petroli. The unit will have a capacity of 75,000 tons a year.

New Cylinder Oil

Gargoyle D.T.E. Marine Oil S-250 is the name of a new cylinder oil now being marketed by Vacuum Oil Co. Ltd.

A special property of the oil is its efficiency in reducing cylinder-liner wear in engines using heavy, boiler-type fuels. The oil has been produced specially to combat the cylinder-liner corrosion which results from the use of these lower quality fuels.

Socony Mobil Oil Co. Inc. (formerly Socony-Vacuum Oil Co.) has been responsible for the development of this new product.

Aerial Survey in East Africa

Three aircraft of Hunting Aerosurveys Ltd. are to undertake aerial photography for mapping purposes over a large area of East Africa embracing parts of Tanganyika, Kenya, Uganda, and Nyasaland. The 1955 contract has been granted to the Company by the Crown Agents as part of the mapping programme being carried out by the Directorate of Colonial Surveys.

Agricultural areas, potential rice-growing land, and areas with a high potential mineral wealth will be covered by the survey.

Natural Gas Survey in Cheshire

Survey work is to be undertaken in the Cheshire basin as part of the D'Arcy Exploration Company's search for natural gas in Britain.

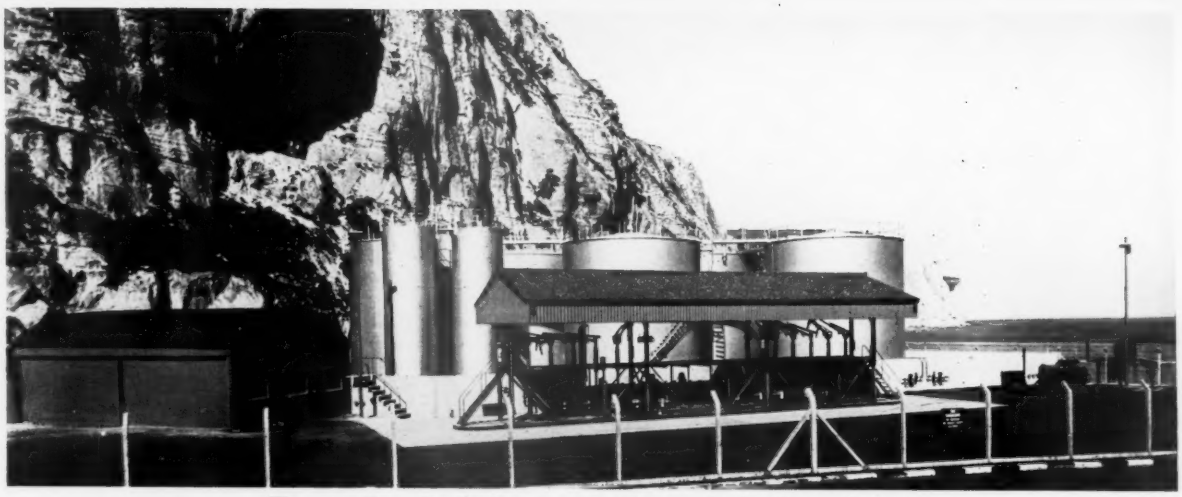
The work is to be carried out on behalf of the Gas Council and will commence with a gravity survey which is expected to occupy three to four months. When the results of this survey have been examined it will be possible to decide whether further detailed survey work is necessary. This in turn may lead to the drilling of test wells—the only way in which the presence or absence of gas can be finally determined.

New Esso Distribution Depot at Dover

A new 1¼-million-gallon distribution depot, built for the Esso Petroleum Co. Ltd. was opened recently at Eastern Dock, Dover Harbour. Supplies for the depot will come by tanker direct from the Esso refinery at Fawley. It will be possible to load four vehicles simultaneously at the new depot by means of remote control and at a rate of 1200 gallons per minute.

The depot was officially opened by the Mayor of Dover and the Mayors of Sandwich, New Romney, Hythe, Deal, and Folkestone were present.

At a reception following the opening ceremony, J. L. N. Pollock, a director of Esso Petroleum Co. Ltd., spoke of the



The new Esso distribution depot at Eastern Dock, Dover Harbour.

oil industry's constant need to modernize and expand its tanker fleets, refineries, and distribution machinery to meet the ever-increasing demand for petroleum products—products which would have to supply most of the vast additional energy requirements necessary to fulfil the Chancellor of the Exchequer's forecast that Britain's standard of living might be doubled in the next 25 years.

Sui-Karachi Gas Pipeline

Work has been completed on the building of a 348-mile long, 16-inch-diameter pipeline to carry natural gas from the Sui gas field in Pakistan to Karachi, via Hyderabad.

The work was carried out by D. & C. and William Press Ltd. in conjunction with the Morrison-Knudsen Company of Pakistan.

The line will deliver 74,000,000 cubic feet of gas per day under natural pressure, and when two booster stations have been installed this will be increased to 110,000,000 cubic feet per day.

Estimated cost of the project, with all ancillaries, is £10,000,000. It is expected that the natural gas will result in a saving of approximately Rs.25,000,000 each year at first.

The Institute of Physics

Sir John Cockcroft (Director of the Atomic Energy Research Establishment, Harwell) has been re-elected President of the Institute of Physics.

Dr W. H. Taylor has been elected a Vice-President, Dr S. Whitehead has been re-elected Honorary Treasurer, and Dr B. P. Dudding re-elected Honorary Secretary. The three new Ordinary Members of the Board are Dr M. R. Hopkins, Dr J. M. A. Lenihan, and Dr J. Taylor.

Committee on Industrial Fires and Explosives

The Fire Research Board of the Department of Scientific and Industrial Research and the Fire Offices' Committee has recently set up a Committee on Industrial Fires and Explosions with Professor A. R. Ubbelohde, F.R.S. as Chairman. The terms of reference of the Committee are as follows:—

(1) to study industrial hazards which arise from the flammability of certain dusts, vapours, and gases; and

(2) to advise on a research programme to provide information that will enable industry and other bodies to avoid, or reduce, the effects of these hazards.

The Committee consists of members drawn from industry and the universities, with representatives from the Factory Department, the Safety in Mines Research Establishment, and the Joint Fire Research Organization. The Secretary of the Committee is Dr D. J. Rasbash, Fire Research Station, Boreham Wood, Herts.

The first meeting of the Committee was held on 29 April. It was decided to consider at subsequent meetings a number of reviews of problems contained within the terms of reference, in order to determine how the available information would be most usefully applied and what are the main gaps in this information.

Oil Exploration in New Zealand

An extensive search for oil—involving an expenditure of £1 million—is to be undertaken by Shell in the North Island, New Zealand. The Shell Company of New Zealand Ltd. is associated in this venture with Todd Brothers Ltd., motor distributors in New Zealand who hold extensive prospecting licences for oil in that country.

Work is to be carried out in the Taranaki and Rangitikei areas in the western part of the North Island. It will begin as soon as arrangements are complete and the necessary technical staff has been drawn from Shell exploration companies operating elsewhere.

* * *

XXVIII INTERNATIONAL CONGRESS OF INDUSTRIAL CHEMISTRY

Corrosion and the protection of materials, lubrication and lubricants, fuels, and petrochemicals, are among the subjects to be discussed at the XXVIIIth Congreso de Quimica Industrial to be held in Madrid from 23 to 31 October this year.

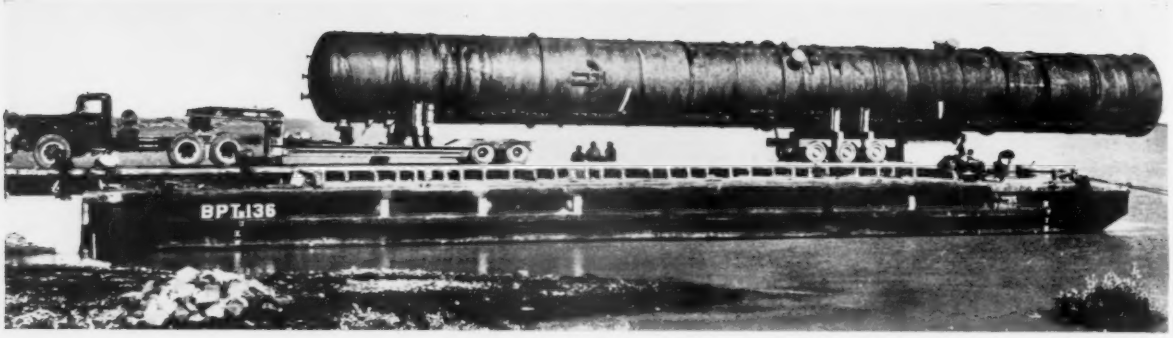
Details regarding the presentation of papers and registration arrangements can be obtained from the Comité de Organizacion of the Congress, Serrano 150, Madrid, Espana.

* * *

SYMPOSIUM ON CORROSION

A Symposium on Corrosion is to be held at the University of Melbourne in December 1955. About thirty papers will be presented by Australian and overseas experts on the fundamental problems of corrosion prevention, buried and immersed corrosion, corrosion in industry, in the oil industry, and in power production.

Further details can be obtained from the secretary of the organizing committee, G. M. Willis, Metallurgy Department, University of Melbourne, Carlton, N.3, Australia.



A Shell photo

A 100-ton fractionating column destined for the catalytic cracking plant of the new Shell refinery near Bombay being floated to Trombay Island after its journey from Woolwich.

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SITUATIONS VACANT

Managerial Personnel needed for Research Centre in the Petroleum Industry

Ente Nazionale Idrocarburi (E.N.I.) has under its supervision a number of Italian Companies active in the field of petroleum and petrochemicals. ENI's major activity is centred in the following items:

— gas and oil field exploration and exploitation (current production: 105 billion cu. ft. of natural gas per year);
— operator of a 2500-mile pipeline system (capacity over 700 million cu. ft. per day);
— owner and operator of a tanker fleet of around 120,000 dwt;
— owner and operator of an extensive network for distribution of petroleum products and LP gas throughout Italy (64 bulk plants, 4000 stations, etc.);
— control over or shareholding in refineries having a processing capacity of about 6 million tons of crude oil per year;
— owner of factories (1500 employees) for construction of machinery;
— shareholding of chemical plants (700 employees) for production of synthetic dyes, detergents, etc.;
— under construction, a petrochemical plant (production capacity—30,000 tons per year of synthetic rubber and 350,000 tons per year of ammonium nitrate).

E.N.I. is organizing a big research centre for investigation and development of petroleum processing and manufacture of petrochemicals. Some departments are expected to begin operation next summer.

Italian or foreign technical experts, with a wide educational background, specific training, organizational and managerial ability, are required to fill positions as heads of the main departments of the laboratories.

Specifically, the following are sought:

(1) **Chemist** or **physicist** with specific knowledge and experience in thermodynamic and chemico-physical problems;
(2) **Chemist** specialized in the preparation of organic compounds, particularly those derived from hydrocarbons;
(3) **Inorganic chemist** soundly and completely acquainted with modern methods of experimentation, research, and testing;
(4) **Engineer or industrial chemist** specially trained in the methods for improving petroleum products applications;
(5) **Engineer or physicist,** with physico-technical and technological training, specialized in the problems of thermotechnics, measurements, and controls;
(6) **Engineer or industrial chemist** with extensive research experience in the field of crude oils processing;
(7) **Engineer or industrial chemist** particularly experienced in extending laboratory procedures to pilot plants;
(8) **Engineer** with good theoretical knowledge and laboratory experience in engine tests on fuels and lubricating oils;
(9) **Engineer or industrial chemist** specially trained both in theory and practice in the fields of corrosion and protective means for materials.

Note.—University degree mandatory.

Applications should state age and other usual personal data, educational background and qualifications, practical experience, etc., and should include a photograph. Please address personally to the: **Presidente dell'Ente Nazionale Idrocarburi, Via Lombardia, 43-Roma-Italy,** with the special note **RISERVATA PERSONALE** (*i.e.*, to be opened by addressee only).

Absolute discretion in every respect is assured.

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Applications are invited by a leading oil company for **Chemical Engineers** or **Applied Chemists** for positions at its new refinery. Applicants should be graduates with at least 10 years' experience in the petroleum industry in the capacity of Process Engineer, Plant Development Chemist, or Plant Control Chemist/Engineer. Experience should include Plant or Process Development, Process and Equipment Efficiencies, Process Calculation, Plant or Equipment revamping and general Process Design. The positions to be filled are senior and there is no age limit. Housing accommodation is available. The company operates a Pension and Life Assurance Scheme, Sickness Benefit Plan, and Sports and Social Club. Applications giving details of qualifications and experience should be sent to Box No. 1093.

A vacancy occurs in the London office of an oil producing company for a **Senior Qualified Petroleum Technologist** with some geological background and administrative experience. The post is pensionable and the salary, which will be in accordance with experience and qualification, will be in the range of £1000-£2000 per annum. Applications will be treated in confidence. Apply with full particulars to Box 1094.

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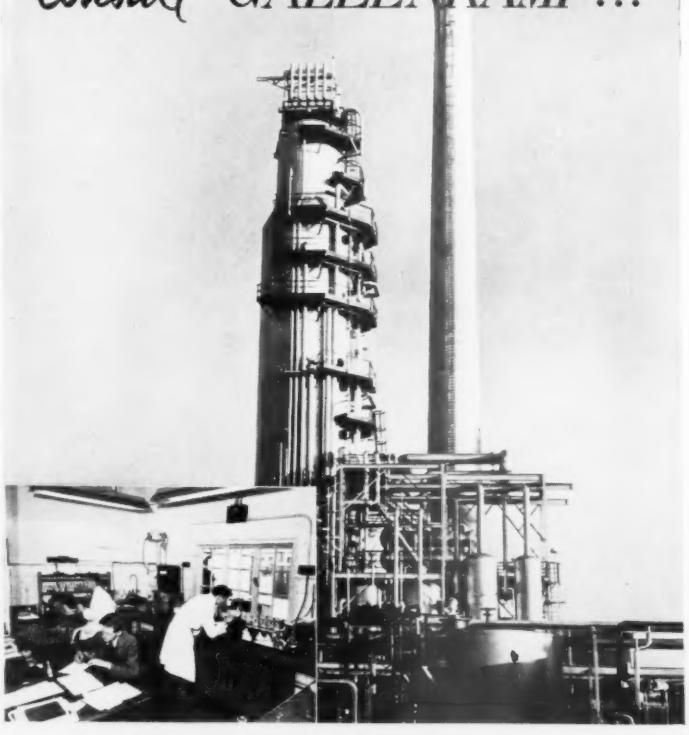

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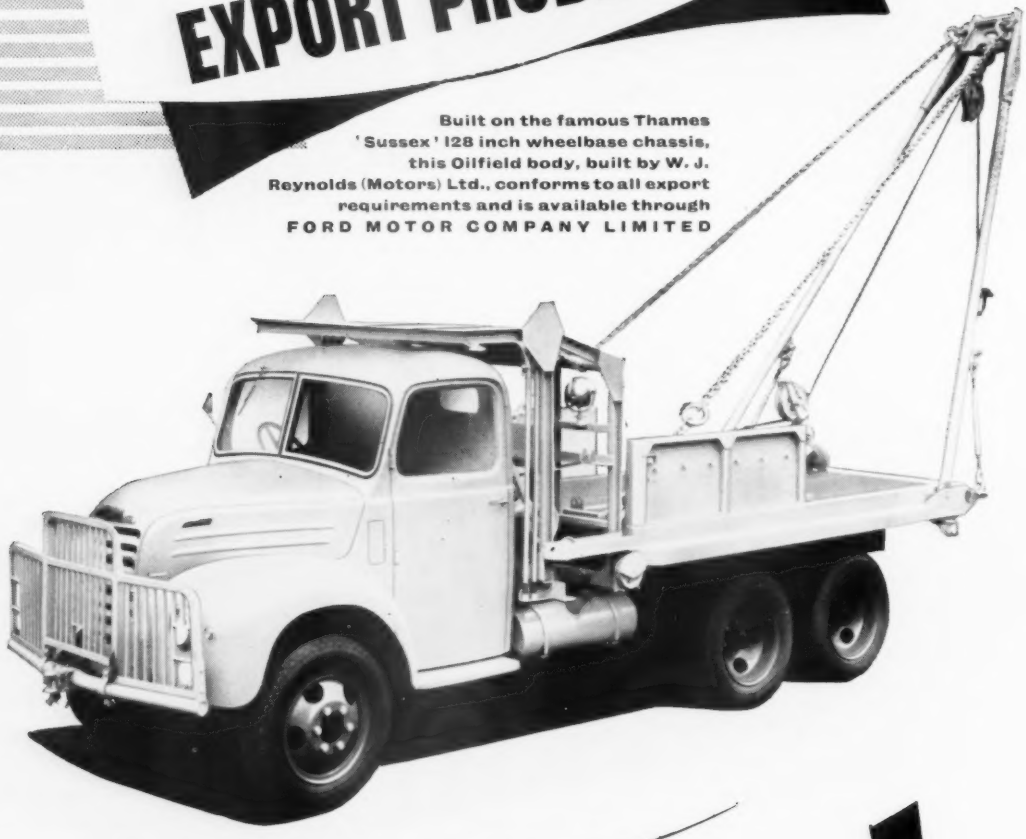

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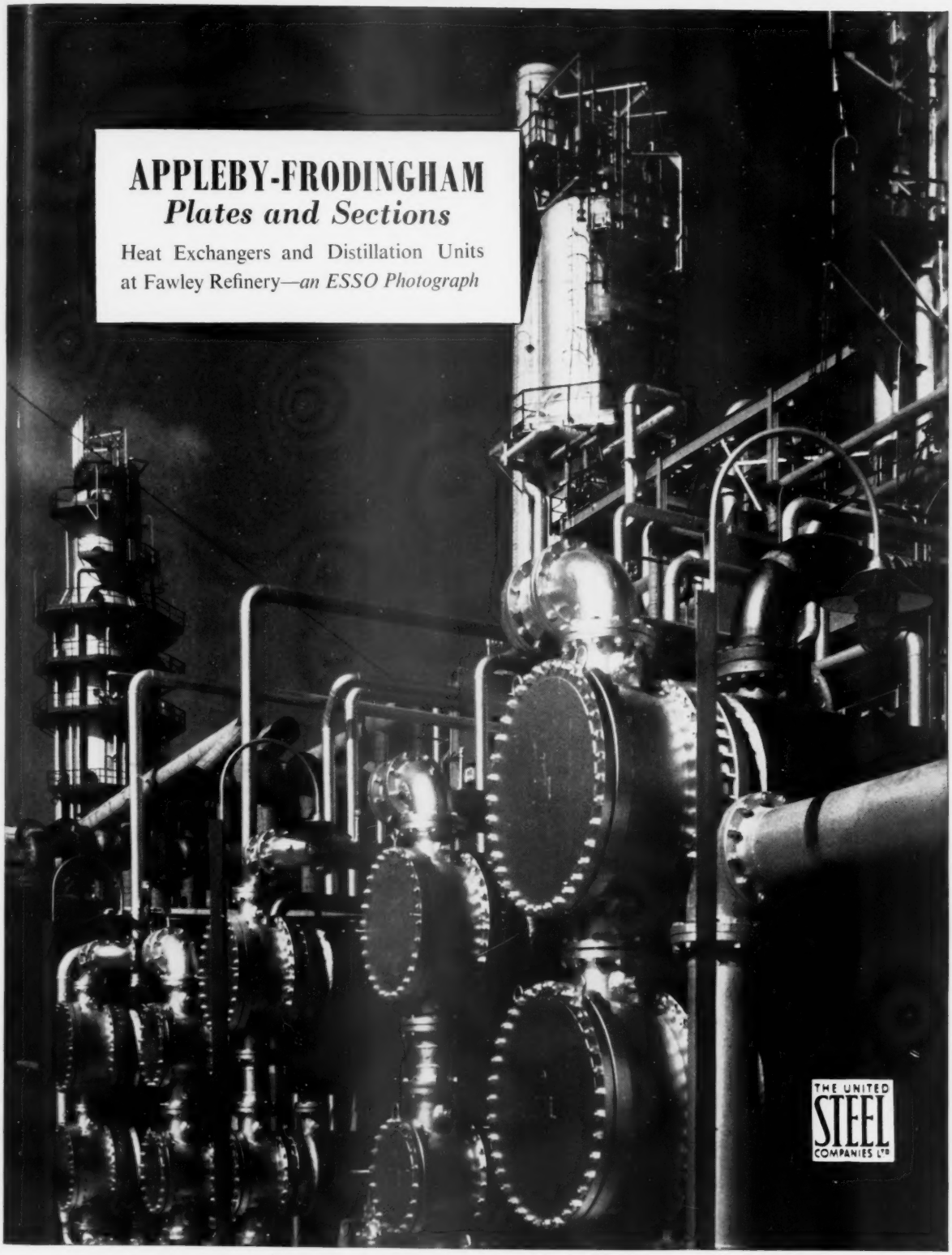

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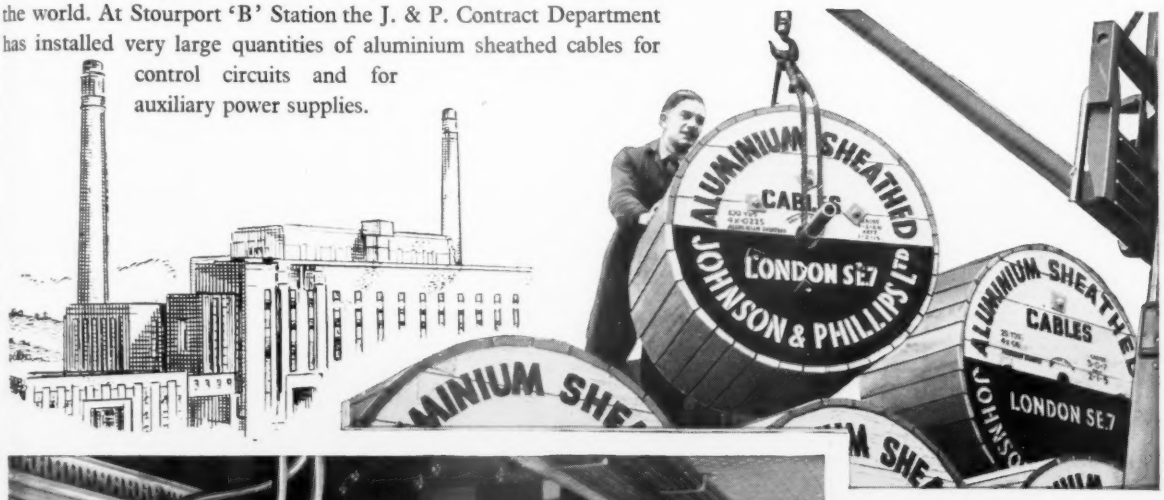

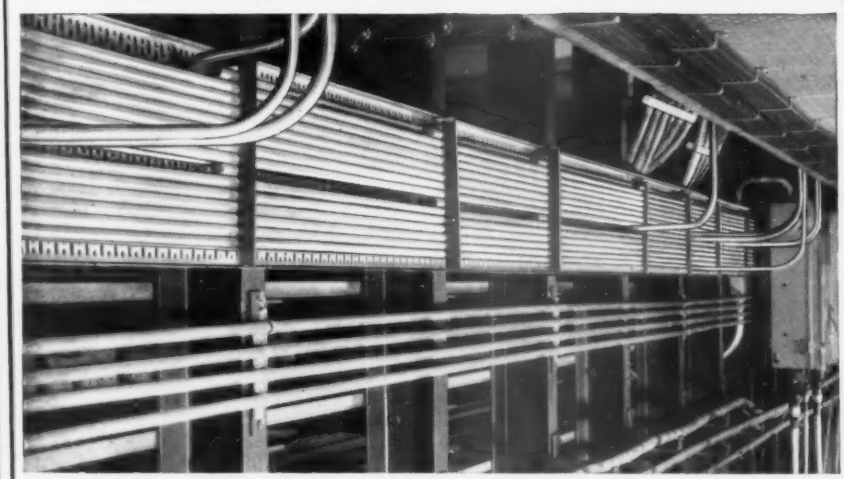

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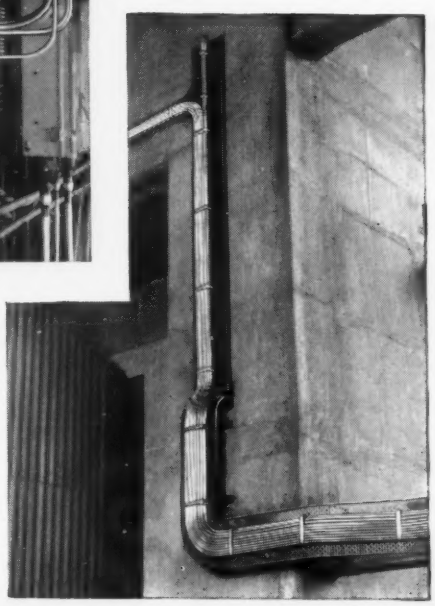

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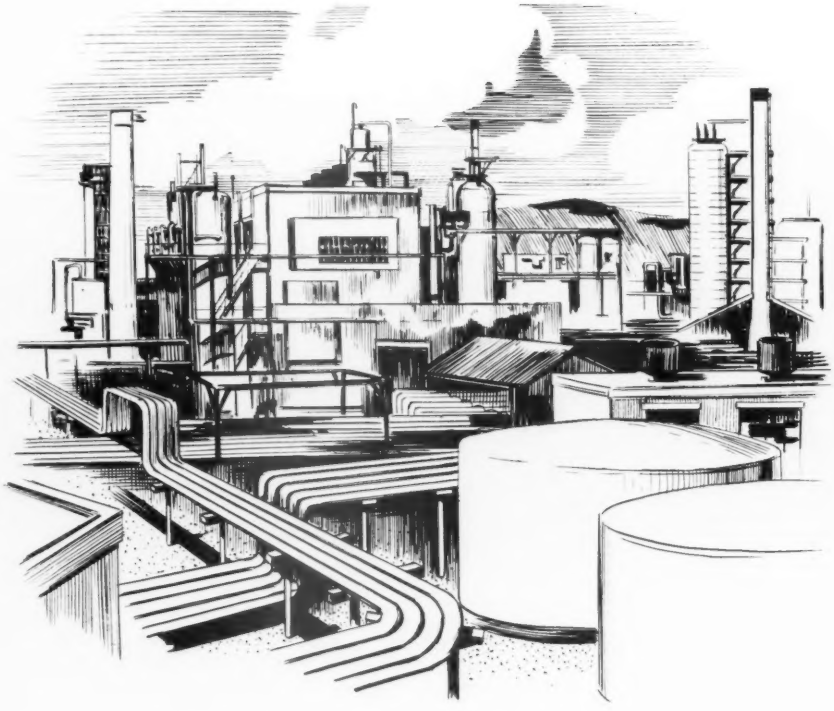

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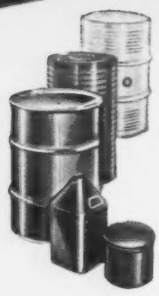

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